ANIMAL EXPERIMENTATION AND MEDICAL PROGRESS

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PREFACE

I HAVE been so frequently asked by earnest inquirers after truth for information as to animal experimentation, and especially for my own publications, that I have concluded to publish these papers in a more permanent and accessible form than in medical and other journals. My thanks are due to the editors and publishers of the journals, etc., in which these papers first appeared, for permission to republish them in this volume.

The papers appear in chronological order. Hence it is important that all their statements of methods, results, and statistics should be considered in connection with the date of the publication of each paper. In some cases I have given in footnotes later information and statistics.

One rather serious objection to republishing these papers in full and just as they were written is that there is considerable repetition. But it must be remembered that they were published or delivered at various times in many years and that they were read or heard by very different sets of readers or hearers. Naturally I wished each address or paper to be complete in itself. Moreover, a potent reason for the repetitions is that they were intended to meet the constantly repeated misstatements by the opponents of experimental research in spite of public exposure of these misstatements. This is well illustrated by the case of Dr. Wentworth, which is fully stated on pages 274–278.

I have frequently used the word "vivisection." It is very objectionable, however, for its meaning is usually extended to cover experiments on the effects of the varied and difficult problems connected with nutrition and physiological chemistry; experiments to determine the effects of "drowning," whether the submersion be of longer

or shorter duration, fatal or non-fatal, and the value of various methods of resuscitation; hypodermic injections of various drugs, etc. None of these involve any "cutting of a living animal" as "vivisection" actually means. Only about six per cent of all the experiments on animals in England (and the same percentage would hold good of America) are strictly "vivisections," and over one half of these animals were killed before regaining consciousness.

Every surgical operation is literally a "human vivisection." In such operations we always take it for granted that an anesthetic has been used, even though no mention of it is made by the operator.

But the "antivivisectionists" constantly quote descriptions of operations on animals omitting all mention of the anesthetic, and, therefore, lead their readers to believe that they were done *without* an anesthetic. Yet in the very papers from which these descriptions are taken the authors distinctly state that an anesthetic *was* given.

In their leaflet entitled "The Anesthetic Delusion," for example, experiments by Crile are thus quoted: —

> Other experiments are described such as "tearing and twisting the sciatic nerve"; "extirpation of an eye and rude manipulation and bruising of the socket"; "forcing air and then water into the stomach, causing its gradual complete dilation, and its final bursting." — From "Surgical Shock," by Dr. Crile.

No mention is made of any anesthetic. Yet every one of these animals *was* anesthetized.

A still more flagrant instance occurs in a letter by Mrs. Henderson, vice-president of the American Antivivisection Society,[1] in which she asserts that "Dr. Crile's book . . . repeatedly describes experiments followed by the words 'no anesthesia.'" Dr. Crile answered this charge by saying that in not a single instance do these words appear in his book.

[1] Philadelphia *Ledger*, December 19, 1913.

After a careful examination of the book myself, I could find no such words anywhere. On the contrary, I found that Dr. Crile alluded some forty times to the anesthetic given to the animals, and on pages 137 and 146, two sections appeared covering a page and a half with the heading, in capitals, "ANÆSTHESIA."

Besides this, on page 14 of the same book, it is distinctly stated that "In all cases the animals were anesthetized, usually by the use of ether, occasionally by chloroform, either alone or with ether. In a few cases curare and morphine were used."

I have four times written Mrs. Henderson and challenged her to give me the pages on which these words appeared, but though these pages were explicitly promised, she has failed to send them. "Harper's Weekly" for May 16, 1914 (page 13), states that Mrs. Henderson had promised the editor "months ago" to specify these pages, and had been reminded of the promise several times, but no such information had been furnished him.

How the profession esteems Dr. Crile is shown by his most recent honor — the award to him of the American Medicine Gold Medal for 1914, as the American physician who, in the judgment of the trustees, has performed the most conspicuous and noteworthy service in the domain of medicine and surgery.

In my paper on "The Influence of Antivivisection on Character" in this volume, I have shown how false is the assertion that "light anesthesia" means "sensibility to pain." Every busy surgeon, in countless operations on human beings, knows that patients often struggle when the first incision is made, showing that the anesthesia is not deep enough to prevent muscular response. Yet, even though the struggles may have been very violent, the patient on returning to consciousness has been in entire ignorance even that an operation has been done.

Operations done on animals before even the discovery of

anesthesia by ether (first publicly used on October 16, 1846) are described by the antivivisectionists without stating the date or the fact that anesthesia was then unknown, and the reader, unversed in medical history, supposes that these operations are done at the present time.

In no illustration by drawing, photograph, painting, or model shown at the antivivisection exhibitions have I ever seen the representation of an etherizer administering an anesthetic. Such illustrations are utterly untrustworthy and misleading. Even impossible operations are shown as though they were commonly done, instead of being simply absurd.

One of the commonest assertions of the antivivisectionists is that all experiments are done behind "closed doors," locked and barred, and guarded against the intrusion of any outsider. Dr. R. M. Pearce, of the University of Pennsylvania,[1] has fully answered this. I can only quote one paragraph: —

> At an exhibit of the American Antivivisection Society two years ago, Dr. Allen J. Smith, then Dean of the Medical School, in conversation with Mrs. Easby, offered to allow her the freedom of the University laboratories and animal house, and later (February 21, 1912) wrote Mrs. Easby reminding her of this offer. These invitations were of no avail, for no member of the Society has either officially or in a private capacity visited the University laboratories. Despite this effort on our part, Mrs. Easby, at the recent exhibit, assured one of the sight-seers that entrance to experimental laboratories was impossible, and with this coupled the statement that anesthesia was not used in any of the operations. As it happened, the young woman to whom these statements were made was our operating-room nurse, who not only has charge of every operation, but administers the anesthetic and knows how frequently strangers come not only into the laboratory, but as well into the operating-room itself.

It is highly diverting that the statement of Mrs. Easby, "that anesthesia was not used in any of the operations,"

[1] *Old Penn*, January 9, 1914.

was unknowingly made to the very young woman who was constantly anesthetizing these very animals!

Dr. W. B. Cannon, Professor of Physiology in the Harvard Medical School, writes me as follows: "None of the doors in my laboratory are locked. Any one could come in at any moment."

The constantly reiterated cry of "human vivisection" to rally the public against experimental research has of late been the chief resource of the antivivisectionists.

In Dr. R. M. Pearce's article, "The Charge of Human Vivisection as Presented in Antivivisection Literature," in the series of pamphlets issued by the American Medical Association[1] there is a full consideration of the American cases of alleged human vivisection, and in my own papers on "The Misstatements of the Antivivisectionists"[2] the foreign cases will be found.

I may especially, however, allude to the evidence of the cruelty of the antivivisectionists as shown in the attack that has been made upon the researches of Drs. Mitchell, Morehouse, and myself as set forth on page 236. Apparently these cruel persons would have forbidden us to seek any relief for those suffering soldiers during the Civil War by testing the effects of any drugs upon them. For these humane efforts to alleviate their horrible sufferings, Drs. Mitchell, Morehouse, and myself are to this day held up to the execration of our fellows as guilty of "human vivisection."

Now let us look the facts squarely in the face.

While animals have benefited enormously from experimental research, the *chief* object has been to benefit the *human race*, to diminish suffering, baffle death, and save the bread-winner to his family or the loved children and others to their relatives. In some cases a whole nation and the world have experienced the benefits. No better instances could be cited than the abolition of yellow fever,

[1] See list on pp. xix, xx. [2] See pp. 110 and 135.

the total disappearance of "hospital gangrene," and the almost total abolition of tetanus (saving in neglected cases). The Panama Canal has been made a possibility; from our Southern cities have been banished the frightful epidemics of yellow fever which impoverished them by thousands of lives and millions of dollars; malaria bids fair to be conquered; typhoid fever, one may say, has disappeared from our armies and is being conquered in civil life.[1]

In the papers published in this volume, I have shown some of the victories which have been won. How has this marvelous progress been made? I answer, "By experiment." Go back to my early professional life fifty years ago. Yellow fever, malaria, hospital gangrene, tetanus, and typhoid were national scourges. Only three ways are open to lessen or abolish these and other diseases: —

1. Try a new remedy or method or operation and try it *first* on man. God forbid!

Yet Mrs. White, the most prominent Philadelphia antivivisectionist, is a pronounced *advocate* of human vivisection.[2]

2. Try them first on the lower animals and *then* on man, provided that the trials on animals showed that they would be an improvement upon existing methods. If such trials on animals proved that they were ineffective or dangerous, then they would *not* be tried on man at all.

3. Try no experiments at all either on animals or man, that is to say, never make any progress.

Remember that the least deviation from the usual practice, whether in using a new drug or even a larger or a smaller dose, or in a different way, is an "experiment." For instance, hypodermic injections, which were unknown till about fifty years ago; puncturing the spinal canal,— "lumbar puncture," — in order to make a diagnosis and later to inject a remedy, was unknown until a little over

[1] See footnote, p. 260.

[2] See text, pp. 251–253, and 254 and footnote,p. 252.

twenty years ago and has only become a routine practice within the last few years; and many new and valuable drugs have been thus introduced into our ordinary practice. Every one of these *at first* was an "experiment."

I am sure that every person of common sense could only choose the second of these three possibilities.

"Clinical observation" is constantly vaunted by the antivivisectionists as the proper and best method of progress. As a clinical teacher for over forty years, I would be the last to decry this method of progress. But the moment you *act* on your "clinical observation" by any new method of treatment, any new dose or drug, any new or even slightly varied operation, *you are making an experiment and on a human being.* If your treatment, dose, drug, or operation is so slight a variation that you may rightly venture to use it without testing it on an animal first, very well. But if you do so, you have nevertheless done an experiment upon a human being. If the departure from prior practice is so great as to involve possible serious results, then I hold that you have *no right* to try it upon a human being first if it is possible first to test it on an animal.

Look for a moment at the difference between the results of clinical observation and of experimental investigation in syphilis. Of course, no experiments on human beings were allowable. Metchnikoff in 1903 first succeeded in inoculating the disease in apes and later in other animals. Experiments, impossible before that time, were immediately begun on animals. In 1905 Schaudinn and Hoffmann thus discovered the germ. In 1910, after a most extraordinary series of experiments with six hundred and five other remedies, which had to be discarded as ineffective or too dangerous, Ehrlich discovered his Salvarsan, or "606," since which time we have had the whip-hand over this desolating plague. Many of the victims of this dreadful disease are innocent women; many others are innocent children,

some already dead when born; others destined happily to an early grave; still others, less fortunate, doomed to drag out a miserable existence.

In seven years experiment on animals did more for alleviating human misery from this one disease than clinical observation on man had done in over four centuries.

The objection is constantly made that animals are so differently constructed from man that inferences from results on animals are of no value in the case of man. That there are a few and even sometimes marked differences is perfectly true, as, for example, the effect of belladonna or of opium on man and on some of the lower animals; but as a matter of fact, barring these few exceptional cases, the organs and functions of man and animal correspond exactly in health and in disease, and the effects of drugs and operations are parallel and in most cases are identical.

The antivivisectionists claim the support of a large number of doctors. Undoubtedly, they have a moderate number, but they are chiefly unknown in the profession. A very few are or were really men of distinction. Professor Henry J. Bigelow, who was born nearly a century ago (1818), the early part of whose professional life was past before anesthesia was known, was familiar with the dreadful sufferings of the animals at Alfort in France, and his very proper protest against it is constantly used by the antivivisectionists. In his later life, however, when anesthesia was well established, he published, in the same volume from which their quotations are taken, an indorsement of experiment by research which the antivivisectionists always fail to quote.[1]

Lawson Tait was undoubtedly a good surgeon and distinguished in his early life. But the reliability of his statistics was seriously questioned. He was much of an Ishmaelite in his profession, and the last years of his life

[1] See pp. 278, 293.

closed in pitiable obscurity. He is constantly quoted by the antivivisectionists as a vigorous opponent of experimental research. In fact he is their "trump card." But, for evident reasons, they never allude to his recantation [1] six years before his death in 1899.

On February 2, 1893, at a conjoint meeting of the Midland Medical Society and the Birmingham Branch of the British Medical Association, to consider the objects of the British Institute of Preventive Medicine (now the Lister Institute) and to further the same, the following resolution was passed: —

Resolved, That the members of the medical profession in Birmingham [Mr. Tait's home] and district cordially approve of the objects of the British Institute of Preventive Medicine.

Mr. Tait spoke in favor of the resolution, saying that he fully assented to the resolution, feeling that, while he objected to a certain class of surgical investigations, "*bacteriological experiments on animals had proved of great value*" (italics mine). Yet the antivivisectionists still flatly deny that bacteriology is true or has proved of any value whatever. The report adds that "this declaration of Mr. Tait was received with amusement and applause."

Another oft-quoted authority against experimental research is Sir William Fergusson, of London. He was an eminent surgeon in his day. He died in 1877, just as the new era in medicine (that of modern experimental research and antisepsis) was beginning,— an era which has witnessed the most wonderful progress ever seen in every department of medicine.

To quote the opinions of these men — Tait (especially in view of his recantation), Bigelow, and Fergusson — men who died fifteen, twenty-four, and thirty-seven years ago — against the opinions of similar leaders in medicine to-day, is like citing the opinions of eminent engineers of

[1] *British Medical Journal*, 1893, vol. I, p. 317.

the last century as to the methods and even the possibility of constructing the Panama Canal, against the opinions and achievements of Colonel Goethals and Colonel Sibert.

The recent prosecution of six professors of the University of Pennsylvania for cruelty to animals was a notable event, especially by reason of the charge to the jury by Judge Brégy. The learned judge ruled that "the law of Pennsylvania does not allow pain and suffering or torment or torture to be inflicted upon dogs for any purpose except for the relief of the suffering of the dog itself." By implication the word "dog" is used in a general sense for "animal" or "living creature."

In the opinion of Samuel Dickson, Esq., the Nestor of the Philadelphia Bar, furnished to the Trustees of the University, it is pointed out (1) that this opinion "is in conflict with what has been the common understanding of the people of this Commonwealth for centuries and with the implications, at least, if not the express language, of the Acts of Assembly upon the subject and the decision of the Supreme Court" of Pennsylvania. (Commonwealth *vs.* Lewis, 140 Pa. 261.) (2) Mr. Dickson then points out some of the consequences which would follow this construction of the law. Thus the gelding of the calf, colt, dog, pig, or chicken to increase its size and value for food, or to make the animal more tractable as a beast of burden; the playing of a game fish on the hook in some cases for hours; the shooting of birds — unless they are instantly (i.e., painlessly) killed — would be illegal and punishable as a "crime"; for all this is done not for the "relief of the dog itself," but for the convenience of man.

Nay, more, if followed to its logical end, would it not be illegal even to net fish as a business, for they are suffocated by their removal from water and are thus "tortured," not for their benefit, but for our food. Would it not also be illegal to poison or trap a rat — even if the plague were at our doors — or a mouse if the house is invaded; to starve the

typhoid-carrying fly in a trap or on "tanglefoot" paper; to poison even a roach, though its instant death underfoot would be allowable?

This trial resulted in a disagreement of the jury. It is understood that the prosecution has abandoned any further proceedings.

The prosecution has produced two good results: —

(1) A special committee of the Board of Trustees of the University made a careful and detailed examination of the Departments of Medicine involving animal experimentation, their methods, rules, care, and food of the animals, condition of the Animal House, etc., and in their report completely exonerate the teachers from all charges of cruelty.

(2) The press, especially of Pennsylvania, and the thinking public have been awakened to the serious danger to the lives and health of the community if the antivivisectionist view prevails; for, as Mr. Dickson points out, not only "must all further experiment be stopped and future research be brought to an end, but it will not be possible to obtain and test vaccine for protection against smallpox by the inoculation of calves, or the antitoxins, from the inoculation of horses, against diphtheria, lockjaw, or the epidemic form of cerebro-spinal meningitis." It would also prevent the inoculation of guinea-pigs to aid us in diagnosing the early stages of tuberculosis; in testing the strength of preparations of ergot on animals, and would thus endanger the lives of many women in cases of hemorrhage in childbirth.

What the *organized* medical profession believe is shown, for example, in the following quotations.

In 1892, the British Medical Association, numbering over 15,000 members and almost all of the leading men of the profession in Great Britain, *unanimously* passed the following resolution: —

"*Resolved*, That this general meeting of the British Medical Association records its opinion that the results of experiments on

living animals have been of inestimable service to man and to the lower animals, and that the continuance and extension of such investigations is essential to the progress of knowledge, the relief of suffering, and the saving of life."[1]

The recent International Medical Congress in London, composed of the most distinguished members of the profession from every civilized country in the world, at a general meeting August 12, 1913, *unanimously* approved the following resolution: —

That this Congress records its conviction that experiments on living animals have proved of the utmost service to medicine in the past, and are indispensable to its future progress. That, accordingly, while strongly deprecating the infliction of unnecessary pain, it is of opinion, alike in the interests of man and of animals, that it is not desirable to restrict competent persons in the performance of such experiments.[2]

At the meeting of the Federation of American Societies for Experimental Biology held in Philadelphia on December 31, 1913, the following declaration was *unanimously* adopted:[3] —

1. We, the members of the Federation of American Societies for Experimental Biology, — comprising the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, and the American Society for Experimental Pathology, — in convention assembled, hereby express our accord with the declaration of the recent International Medical Congress and other authoritative medical organizations, in favor of the scientific method designated properly animal experimentation, but sometimes vivisection.

2. We point to the remarkable and innumerable achievements, by means of animal experimentation in the past, in advancing the knowledge of biological laws and devising methods of pro-

[1] *British Medical Journal,* August 6, 1892, p. 306.
[2] *British Medical Journal,* 1913, vol. II, p. 429.
[3] *Science,* February 6, 1914, p. 217.

cedure for the cure of disease and for the prevention of suffering in human beings and lower animals. We emphasize the necessity of animal experimentation in continuing similar beneficent work in the future.

3. We are firmly opposed to cruelty to animals. We heartily support all humane efforts to prevent the wanton infliction of pain. The vast majority of experiments on animals need not be and, in fact, are not accompanied by any pain whatsoever. Under the regulations already in force, which reduce discomfort to the least possible amount and which require the decision of doubtful cases by the responsible laboratory director, the performance of those rare experiments which involve pain is, we believe, justifiable.

4. We regret the widespread lack of information regarding the aims, the achievements, and procedures of animal experimentation. We deplore the persistent misrepresentation of these aims, achievements, and procedures by those who are opposed to this scientific method. We protest against the frequent denunciations of self-sacrificing, high-minded men of science who are devoting their lives to the welfare of mankind in efforts to solve the complicated problems of living beings and their diseases.

In 1908, the two largest scentific bodies of the United States, the American Medical Association[1] and the American Association for the Advancement of Science,[2] *unanimously* adopted the following resolutions:[3] —

WHEREAS, from time to time, attempts, fostered largely by erroneous statements and accusations and false sentiment and prejudice, are made in some parts of this country to enact specific legislation, prescribing the conditions under which experiments on animals may or may not be performed; be it

A. *Resolved*, by the Association, That animal experimentation has been of incalculable benefit to medical science and art, the progress of which is as absolutely dependent on experimental methods as are all the physical and natural sciences.

[1] *Journal, American Medical Association*, June 13, 1908, p. 2001.
[2] *Ibid.*, January 9, 1909, pp. 144, 145.
[3] Very slight verbal variations exist in "B."

B. *Resolved*, That no abuse of the practice of animal experimentation in this country has been shown to exist to warrant specific legislation, nor is there any probability of such abuse arising.

C. *Resolved*, by the Association, That the unrestricted performance by proper persons of scientific experiments on living animals is essential to the maintenance and progress of medicine and biology.

These resolutions represent the *collective opinion of the medical profession*, not only of Great Britain and America, but of the whole civilized world.

Per contra, there is not, so far as I know, a single resolution of any scientific body expressing the opposite opinion.

In addition to all this the following quotation from the *unanimous Report* of the English Royal Commission on Vivisection, *composed of the advocates and opponents of animal experimentation*, is published in their final *Report* in 1912, on page 20.

We desire to state that the harrowing descriptions and illustrations of operations inflicted on animals, which are freely circulated by post, advertisement, or otherwise, are in many cases calculated to mislead the public, so far as they suggest that the animals in question were not under an anesthetic. To represent that animals subject to experiments in this country are wantonly tortured would, in our opinion, be absolutely false.

The Bureau on Protection of Medical Research, appointed by the Council on Health and Public Instruction of the American Medical Association, has published a series of twenty-six pamphlets, a list of which is appended. The pamphlets in this series set forth from different aspects the value and importance of experimental research very clearly. The price is only a few cents each.

I beg to express to the distinguished President Emeritus of Harvard University, Dr. Charles W. Eliot, my warm thanks for his kindness in furnishing the Introductory Note. His indorsement hall-marks any book.

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CONTENTS

INTRODUCTION

Dr. Keen describes in this book, in a very interesting and convincing manner, the new surgery of the last forty years and its extraordinarily beneficent results. He shows that the progress of surgery has taken effect in all parts of the human body, including the brain, spine, chest, stomach, intestines, liver, gall bladder, appendix, pancreas, spleen, and kidneys, and the arteries, veins, and nerves; that many operations which were impossible, or had a high mortality, before aseptic surgery was invented, have become not only possible but safe; and that innumerable lives have been saved, and are continually being saved, by operations new within forty years. He also demonstrates that the new surgery has reduced very much the period required for recovery, as well as the death-rate, after a large variety of operations, — such as those for compound fractures, ovariotomy, hernia, goiter, and the removal of cancers and tumors, — and that the proportion of complete and rapid cures after operation has been greatly increased. He points out that lockjaw has been almost abolished; that the direct transfusion of blood has been achieved; that the mortality from diphtheria and cerebro-spinal meningitis — two formidable diseases now successfully treated by antitoxins — has been greatly reduced; that yellow fever has been abolished as a destructive epidemic; and that child-birth fever, formerly very destructive, has become rare.

The new surgery has been made possible by the combination of anesthesia and asepticism; but asepticism owes to animal experimentation, guided and furthered by the new science and art of bacteriology, its origin and its successful applications. Through animal experimentation, also, numerous valuable drugs have been tested before being

used on man; and the beneficent use of each has been defined.

The immense benefits which modern surgery and serum-therapy have conferred on mankind are therefore due to animal experimentation.

Since experiments on the living human being are seldom possible, or indeed justifiable, except by request of the patient in desperate cases, and since all scientific knowledge comes by the way of experiment, the progress of medicine and surgery was very slow, so long as the only means of advancing them was by the study of sick or injured human bodies and the *post-mortem* examinations. Animal experimentation has already made progress rapid, and will be even more fruitful in the future.

In the manufacture of the serums now used in the treatment of diseases, as in diphtheria, tetanus, and cerebro-spinal meningitis, the serum has to be tested on animals before it is used on human beings; and therefore some rabbits, guinea-pigs, or other small animals are sacrificed during the process of manufacturing serums of good quality. In learning how to sew together two bowel ends or the two ends of an artery, vein, or nerve which has been severed, a few dogs and cats were sacrificed. In learning the localization of function in the different parts of the human brain, many animals had to be sacrificed before the human skull could safely be entered at the right spot for relieving a hemorrhage, or removing a tumor.

Through these sacrifices of animal life or happiness, always made as painless as possible, surgeons and physicians have been able to save innumerable human lives which, without the help of the new surgery and therapy, would have been lost, and to relieve or remedy innumerable cases of human suffering and injury. Is it justifiable to use animals in this way?

The human race daily devours animals, large and small, by the million, cuts off animal life by eating innumerable

eggs from which animals would develop, makes the animals capable of domestication work for them in multifarious ways, and thereby deprives them of their liberty and of their natural joys. The number of animals used for the benefit of the human race in making possible the recent advances of surgery and medicine is insignificant, indeed infinitesimal, compared with the number used for human food and human service; but the benefits to mankind which result from animal experimentation are immeasurable in quantity, and very precious in quality.

How many rabbits or guinea-pigs is it justifiable to incommode or kill, in order to save the life of a child attacked by diphtheria? How many monkeys would a competent experimenter be justified in sacrificing, in order to find a sure treatment for infantile paralysis? How many rats is it justifiable for men to kill, in order to protect a city from an epidemic of bubonic plague? Dr. Keen suggests at many points the reasonable answer to all such questions as these.

One third of the book is devoted to the exposition of the unreasonableness, inaccuracy, and indifference to truth and justice manifested by the antivivisectionists in selecting the premises of their argument against animal experimentation. He points out over and over again that the antivivisectionists would be the cruel people, if they could have their way, cruel to their own kind; and that the surgeons and physiologists, and the men who devote themselves to medical and surgical research are carrying on the most humane work now done in the world. Dr. Keen thus sets before his readers in a striking way the evil consequences which may flow from the morbid perversion of a humane, kindly, or altruistic sentiment. In this case, the common sense of mankind ought to be able to prevent the victims of a perverted sentiment from doing serious harm to the human race.

One must always remember that when by a course of

experiments on a few animals a scientific discoverer arrives at knowledge of the mode of transmission of a dangerous pestilence, at a new means of preventing the spread of a disease, or at a new medical or surgical treatment of a disease or a wound, the benefits of the discovery go on generation after generation, multiplying as they go. There lies an immense hope for the future! To propose that such a hope shall be blighted by stopping animal experimentation argues an extraordinary infatuation in the proposer.

Dr. Keen is a competent witness to the progress of surgery during the past fifty years. His surgical career began in 1862, when aseptic surgery was unknown; so that he has personally seen the whole development of modern surgery, and indeed has actively participated in its achievements. His career proves him to be a clear-sighted, alert, and diligent student, and a wise and skillful practitioner. He is also, like most good surgeons, a humane and sympathetic man.

Charles W. Eliot.

7 October, 1914.

ANIMAL EXPERIMENTATION AND MEDICAL PROGRESS

ANIMAL EXPERIMENTATION AND MEDICAL PROGRESS

OUR RECENT DEBTS TO VIVISECTION [1]

It is to one of the medical issues of the day to which I purpose to direct your attention at present, — one as to which, especially among women, intense feeling has been aroused, — namely, the question of experiments upon animals.

Epithets and invective have been freely used, but, as befits the audience and the occasion, I shall endeavor to approach it in a perfectly calm and fair spirit, seeking to lay before you only one aspect of a many-sided question, — namely, the actual practical benefits it has conferred upon man and animals, — a fact that is constantly denied, but which medical evidence proves to be incontestable.

I shall not consider the important older discoveries it has given us, but only those since 1850, almost all of which are within my own personal recollection. Even of these I must omit nearly all of its contributions to physiology and to pathology, though so much of our practice is based upon these, and confine myself to the advances it has enabled us to make in medical and surgical practice. I shall endeavor to state its claims with moderation, for an extravagant claim always produces a revulsion against the claimant, and is as unwise as it is unscientific.

Again it must be borne in mind that, as in nearly every other advance in civilization and in society, so in medicine, causes are rarely single, but generally multiple and inter-

[1] The address to the graduates at the Thirty-third Commencement of the Woman's Medical College of Pennsylvania, March 11, 1885. Reprinted by permission from the *Popular Science Monthly* for May, 1885.

woven. While vivisection has been a most potent factor in medical progress, it is only one of several factors, the disentanglement of which and the *exact* balancing of how much is due to this or to that are often difficult and sometimes impossible. Let me add one word more. All that I may say is purely upon my own responsibility. I commit the opinion of no one else to any view or any statement of fact.

Medicine in the future must either grow worse, stand still, or grow better.

To grow worse, we must forget our present knowledge — happily, an inconceivable idea.

To stand still, we must accept our present knowledge as a finality, complacently pursuing the well-worn paths; neither hoping nor trying for anything better — happily, again, an impossibility.

To grow better we must try new methods, give new drugs, perform new operations, or perform old ones in new ways; that is to say, we must make experiments. To these experiments there must be a beginning: they must be tried first on some living body, for it is often forgotten that the dead body can only teach manual dexterity. They must then be tried either on an animal or on *you*. Which shall it be? In many cases, of course, which involve little or no risk to life or health, it is perfectly legitimate to test probable improvements on man first, although one of the gravest and most frequent charges made against us doctors is that we are experimenting upon our patients.

But in many cases they involve great risk to life or health. Here they cannot, nay, they must not, be tested first upon man. Must we, then, absolutely forego them, no matter how much of promise for life and health and happiness they possess? If not, the only alternative we have is to try them on the lower animals, and we would be most unwise — nay, more, we would be cruel, cruel both to man and to

animals — if we refused to pain or even to slay a few animals, that thousands, both of men and of animals, might live.

Who would think it right to put a few drops of the hydrochlorate of cocain (a year ago almost an unknown drug) into the eye of a man, not knowing what frightful inflammation or even loss of sight might follow? Had one dared to do it, and had the result been disastrous, would not the law have held him guilty and punished him severely, and all of us have said Amen? But so did Christison with Calabar bean, and well-nigh lost his own life. So did Toynbee with prussic acid on himself, and was found dead in his laboratory.[1] Accordingly, Koller, of Vienna, properly and wisely tried cocain first on animals,[2] and then, finding its beneficial effects, tried it upon man with like results, and one of the most remarkable drugs of modern times was thus made available. We are only on the threshold of its usefulness. It has been used in the eye, the ear, the nose, the mouth, the larynx, and all other mucous membranes, in the removal of tumors, and as an internal medicine. When its physiological action has been still more thoroughly and systematically investigated, its poisonous dose ascertained, when we know how it works, what its effects are upon the blood-pressure, the heart, the nerves, the blood-vessels, — effects that cannot be accurately studied upon man, — its usefulness may be increased to an extent as yet but little dreamed of. Should it only soothe the last painful hours of our great hero, General Grant, a nation will bless it and the experiments which gave it effect. Moreover, had the experiments of Dr. Isaac Ott, of Easton,[3] on this very drug, borne their due fruit, America would have had the honor and the human race the benefits of cocain ten years ago — ten years of needless suffering!

[1] See also Sir Lyon Playfair's statement on p. 258.

[2] *Archives of Ophthalmology*, September and December, 1884, p. 402; New York, Putnam's.

[3] Ott, *Cocain, Veratrine, and Gelsemium*, Philadelphia, 1874.

This is but one illustration of the value of experiments upon animals in the realm of new drugs. In fact, substitute for cocain other drugs, or new operations, or new methods of medical treatment, and the argument repeats itself for each. Within the last thirty years a multitude of new drugs have thus been discovered, and their effects have been either first tested upon animals, or their properties studied exhaustively in a manner impracticable upon man. I will only enumerate some of them, since time will not allow me to enter upon each in detail. Thus have been introduced lily-of-the-valley in heart disease, yellow jasmine in diseases of the heart and nervous system, paraldehyde and chloral hydrate, so valuable for sleep, caffein for headache, eucalyptus as an antiseptic and in medicine, nitroglycerin for nervous maladies, Calabar bean for disease of the eye and nervous system, naphthalin and iodoform in surgery, quebracho as an antispasmodic, antipyrin and kairin in fever, jaborandi in dropsy, salicylic acid in rheumatism, nitrite of amyl in epilepsy and intermittent fever, jequirity in ophthalmic surgery, piscidia as a substitute for opium, the hypodermatic method of using drugs, and so on through a long list. And, as to the old drugs, it may be truly said that we have little exact — that is, scientific — knowledge of any one except through experiments upon animals.[1]

[1] For three hundred years digitalis, for instance, has been given as a *depressant* of the heart, and, when a student, I was taught to avoid it carefully when the heart was weak. But the accurate experiments of Bernard and others have shown that it is, on the contrary, actually a *heart tonic and stimulant.* So long as I live I shall never forget the intense joy of myself and the agonized parents, when one bright young life was brought back from the very grave, some five years ago, by the knowledge of this fact, and this is but one of many such cases. Thus have the action and dangers of our common anesthetics been positively and accurately ascertained; thus the action of ergot on the blood-vessels, explaining alike its danger as an article of food and its wonderful use in certain tumors of the uterus and diseases of the nervous centers; thus, too, every one who gives opium in its various forms is a debtor to Bernard, and every one who gives strychnin a disciple of Magendie.

"As ergot is a drug that varies greatly in physiological activity in its

Let us now see something of what America has done in advancing practical medicine by vivisection. In passing, I may say that the assertion that America has contributed but little, so far from being an argument for the restriction of vivisection, is a strong argument for its further cultivation, in order that greater good may result from remarkable discoveries here, equal to those that I shall show have been made in Europe.

Wounds of the abdomen, especially gunshot wounds, are among the most fatal injuries known to surgery. A small, innocent-looking, external pistol wound may cover multiple and almost inevitably fatal perforations of the abdominal viscera. The recoveries from 3717 such wounds during the late Civil War only numbered 444, and of those with escape of the intestinal contents the recoveries, says Otis, may be counted on one's fingers. The prevailing treatment as laid down in our textbooks has been purely conservative, treating symptoms as they arise. The brilliant results achieved in other abdominal operations have led a few bold spirits, such as our own Sims, Gross, Otis, McGuire, and others, to advocate the opening of the abdomen and the repair of the injuries found.

In May of last year, Parkes, of Chicago, reported to the American Medical Association [1] a series of systematic experiments on thirty-seven dogs, that were etherized, then shot, the abdomen opened, and the wounds of the intestines,

crude state and cannot be *chemically* assayed with advantage, the physician should always use a preparation which has been *physiologically* tested by the manufacturer before it is placed on the market." (Hare's *Practical Therapeutics*, 11th ed., 1905, p. 236.)

The physiological test of ergot is by giving it to animals and observing the effects on the caliber of the small blood-vessels. Unless so physiologically tested, the physician, surgeon, and especially the obstetrician, may be ignorantly using a wholly inert preparation, thus seriously endangering human life.

[1] *Medical News*, May 17, 1884. I shall refer readers frequently to this journal, as it is often more accessible than foreign journals, and it will refer them to the original papers.

arteries, mesentery, etc., treated by appropriate surgical methods. The results confirmed the belief awakened by earlier experiments and observations that surgery could grapple successfully with multiple and formidable wounds, by sewing them up in various ways, or even by removing a piece of the bowel and uniting the cut ends. Hard upon the heels of this important paper, and largely as its result, comes a striking improvement in practice. And remember that this is only the first fruit of a rich harvest for all future time, in all countries, in peace and in war.

November 2, of last year, a man was brought to the Chambers Street Hospital, in New York, with a pistol-shot wound in the abdomen. Under careful antiseptic precautions, and following the indications of Parkes, the abdomen was opened by Dr. Bull,[1] coil after coil of the intestines was drawn out, the bullet was found and removed, and seven wounds of the intestines were successfully discovered and properly treated, and the patient made an uninterrupted recovery. A recovery, after so many wounds, any one of which would necessarily have been fatal under the old methods of treatment, shows that we have now entered upon a proper and successful method of treatment for such frightful accidents.[2]

This is but one of the remarkable achievements of late years in abdominal surgery. The spleen has been removed, part of the stomach has been cut out for cancer,[3] part of the bladder [4] has been dissected away, the entire gall-bladder has been removed, and several inches of the intestine have been cut out,[5] all with the most remarkable success. To all

[1] *Medical News*, February 14, 1885.

[2] Since 1885 hundreds of such wounds have been successfully treated and recovery has followed after as many as nineteen wounds of the bowels. (1914.)

[3] Since 1885 the entire stomach has been repeatedly removed. (1914.)

[4] Since then the entire bladder has been repeatedly removed. (1914.)

[5] Much larger portions have been removed since then, even as much as eight feet eight inches, with success. (1914.)

of these, experiments upon animals have either led the way or have taught us better methods. To recite each in detail would occupy too much time, but one illustration I must not omit, for the improvement produced by it and other experiments, affects every abdominal operation. When I was a student, the peritoneum was avoided by knife and needle wherever possible. After the death of his fourth case of ovariotomy, Mr. (now Sir Spencer) Wells,[1] in making the *post-mortem*, was led to believe that the then received treatment of the peritoneum was incorrect, and that he ought to bring its surfaces in contact in order to obtain secure union. Accordingly, instead of testing his ideas upon women, he experimented upon a few dogs, and found that his suspicions were correct. Since then it has been accepted as a cardinal point in all abdominal operations. Following this came improvements in the ligatures used, in the method of treating the pedicle, in the use of antiseptics, etc., all more or less the result of experiments upon animals, and what are the results? Taking successive hundreds of cases, Sir Spencer Wells's percentage of mortality has decreased steadily from thirty-four per cent to eleven per cent.

Since then, others have reduced the percentage of deaths after ovariotomy to three in the hundred; and Martin, of Berlin, has lost but one patient from blood-poisoning in his last one hundred and thirty cases.

It cannot be claimed, of course, as to *all* this wonderful history of abdominal surgery — and remember that in 1862, when I was a medical student, I heard ovariotomists denounced from a professor's chair as murderers! — that experiments upon animals have done the whole work. No one man, no one series of experiments has sufficed, and experiment *alone* would not have done it. But had such experiments not been made on animals, as to the peritoneum, the pedicle, the sutures, the ligatures, etc., we should be far

[1] Wells, *Ovarian and Uterine Tumors*, 1882, p. 197.

behind where we now are, and still be ignorantly sacrificing human life and causing human suffering.

But to return to America. The first condition to successful treatment is an accurate knowledge of what any disease is — its cause and its course; then we may guide it, and in due time, it may be, cure it.

Before Dr. H. C. Wood's [1] accurate experiments on the effects of heat on animals, the nature and effects of sunstroke were almost matters of mere conjecture. Every one had his own theory, and the treatment was equally varied. Even the heat-effects of fever itself — the commonest of all symptoms of disease — were ill understood. Wood exposed animals to temperatures of 120° to 130° F. and studied the effects. These experiments have often been alluded to as "baking animals alive." You will note that the heat was no greater than that to which laborers are frequently exposed in our hot summer days, when working in the sun or in many industrial works. His experiments showed that the effects of sunstroke — or, as he happily termed it, thermic or heat fever, a scientific name now widely adopted — were solely due to the heat, death following from coagulation of the muscular structure of the heart, or by its effects on the brain. They explained also many of the phenomena of ordinary fever as the result of heat alone. They have established the rational and now generally adopted treatment of sunstroke by reduction of the body-temperature; and the same method is now beginning to be appreciated and employed in ordinary fever.[2]

The same observer, with Dr. Formad, has made important experiments on the nature of diphtheria, and when we learn, as we probably soon shall, how to deal with the

[1] Wood, *Thermic Fever or Sunstroke*, Philadelphia, 1872.

[2] Eighteen out of Wood's experiments were on the general effects of heat, as above alluded to. In six others the local effects of heat (135° to 190° F.) on the brain, and in four others the local effects (up to 140° F.) on the nerves were studied and gave most valuable results, entirely and evidently unattainable on man.

microscopical forms of life which seem to be its cause, it will not be too much to hope that we may be able to cope far more successfully with a disease now desolating so many homes.[1]

In India alone twenty thousand human beings die annually from snake-bite,[2] and as yet no antidote has been discovered. How can we *search intelligently* for an antidote until we know accurately the effects of the poison? This cannot be studied on man; we must resort to animals, or else let the holocaust go on. Accordingly, Dr. (now Sir) Lauder Brunton began such a series of experiments in London, but was stopped by the stringent antivivisection laws there in force. But Drs. Weir Mitchell and Reichert,[3] in this city, have recently undertaken experiments on cobra and rattlesnake venom, the cobra-poison being furnished, be it observed, by the British Government, whose own laws have prevented investigations for the benefit of its own subjects! The results are as yet only partly made known, but they have been brilliantly successful in showing that there are two poisons in such venom, each of which has been isolated and its effects studied. The first step has been taken — the poison is known. Who will raise a finger to stop progress toward the second — the antidote?[4] Can the sacrifice of a few scores of animals each year in such research weigh for a moment against the continuous annual sacrifice of twenty thousand human beings?[5]

[1] The remarkable results in lessening the mortality from diphtheria by the use of the antitoxin discovered since this address was first published are now universally known. Thousands of human lives, especially of children, are saved annually in this country alone. (1914.)

[2] Fayrer, *Thanatophidia of India*, p. 32.

[3] *Medical News*, April 28, 1883.

[4] Since then Calmette and Noguchi have both announced an antivenene or antidote to the venom of snakes, but they still leave much to be desired. (1914.)

[5] I am permitted by Rev. R. M. Luther, of this city, to state the following fact in illustration of the practical value of vivisection in snake-bite: When a missionary in Burmah, he and his brother-in-law, Rev. Mr. Vinton (two missionary vivisectionists!), made a number of experiments to dis-

The modern history of anesthetics is also of interest. To say nothing of ether and chloroform, whose safer use Bert has investigated in France, nor of cocain, to which I have already alluded, let us see what experiments on animals have shown us as to bromid of ethyl — an anesthetic lately revived in surgery. Its revival has quickly been followed by its abandonment on account of the frequent sacrifice of human life — that is to say, *experiments on human beings* have proved it to be deadly. Now, Dr. H. C. Wood,[1] soon after its reintroduction, made a study of its effects on animals, and showed its physiological dangers. Had his warnings been heeded, not a few human lives would have been saved.

The ideal anesthetic, that will abolish pain without abolishing consciousness, and do so without danger, is yet to be found. Cocain is our nearest approach to it. Now, in all fairness and common sense, would it be real kindness or real cruelty to obstruct the search for such an anesthetic — a search which will surely be rewarded by success, but which, if not carried on by experiments on animals, must be tried by deadly experiments upon man, or else be entirely given up?

In 1869 I was called to see a man suffering to the last degree from an abscess in the loin. I recognized the fact that it arose from the kidney, but I was powerless. All that I could do was to mitigate his pitiless sufferings and that, alas! but little, till death came to his relief, after nearly a year of untold agony. I have never forgotten his

cover an antidote to the poison of the "brown viper" — a snake but little less venomous than the cobra. They found a substance which is an antidote in about sixty per cent of the cases if applied at once. Thah Mway, one of their native preachers, when bitten by the brown viper, had some of this antidote with him, and by its use his life was saved when on the verge of death. This one life saved, it is estimated, has been the means of leading two thousand Karens to embrace Christianity. Was not this one life worth all the dogs used in the experiments — to make no mention of the many other lives that will be saved in all the future?

[1] Philadelphia *Medical Times*, April 24, 1880.

sufferings, nor the sharp pain I felt when I learned, two years later, how I might possibly have saved his life. In the very same year (1869), Simon, of Heidelberg,[1] had a woman under his care suffering from urinary fistula[2] from a healthy kidney — a surgical accident he in vain tried to heal. That she could live with one kidney had the other gradually been disabled by disease was probable, for one such diseased kidney had been already removed three times when mistaken for ovarian disease. But no one had removed a healthy kidney, and then studied the effects on the remaining kidney and upon the heart; no one had tested what was the best method of reaching the kidney, whether by the abdomen or the loin, or how to deal with its capsule, or the hemorrhage, or the surgical after-effects. Of course, Simon could have tried the experiment on his patient, blindly trusting to Providence for the result. But he chose the wiser course. He studied the previous literature, experimented on a number of dogs, and watched the points above noted, tried various methods of operating upon the dead body, and, after weighing all the *pros* and *cons*, deliberately cut down upon the kidney of his patient after a carefully formulated plan, not by the abdomen, but through the loin, and saved her life. She died in 1877, after eight years of healthy life, free from her loathsome disorder.

Now, what have been the results of these experiments upon a few dogs? One hundred and ninety-eight times the kidney has been removed, and 105 human lives have been saved; 83 times abscesses in the kidney have been opened, and 66 lives saved; 17 times stones have been removed from the kidney without a single death — or, in all, in the last fifteen years, 298 operations, and 188 human lives saved. Besides this, as an extension of the operation in 17 cases, in

[1] Simon, *Chirurgie der Nieren*, 1871, preface.

[2] An opening in the skin through which the urine constantly escapes externally.

which the kidney, having no such attachments as ought to anchor it in place, was floating loosely in the abdomen and was a source of severe pain, it has been cut down upon and sewed fast in its proper place; and all of these patients but one recovered.[1]

Looking to the future, when not hundreds, but thousands, of human beings will enjoy the benefits of these operations, and in increasing percentages of recoveries, are not the sufferings inflicted on these few dogs amply justified as in the highest sense kind and humane?[2]

Not long since Dr. (later Sir David) Ferrier, of London, was prosecuted for the alleged performance of certain experiments on the brains of the lower animals. With Fritsch, Hitzig, Goltz, Yeo, and others, he had destroyed or galvanized certain limited areas of the brain (and it must not be forgotten that the brain is wholly without the sense of pain), and so determined the exact nervous centers for certain limited groups of muscles. As a result of their labors, the brain is now mapped out with reasonable accuracy, so that, given certain hitherto ill-understood or obscure localized symptoms, we can now say that there is certainly a tumor, an abscess, or other disease in precisely this or that locality. True, we can doubtfully infer somewhat of the same from the cruel experiments of disease on

[1] In the twenty-nine years since this address was delivered these figures have been multiplied many fold. (1914.)

[2] Very erroneous views prevail as to the sufferings of animals from experiments upon them. Many persons suppose that "vivisection" means deliberate "cutting up" of an animal without using any anesthetic, little by little, till not enough is left to live. So far is this from the truth, that Professor Gerald Yeo, from the actual reports of vivisectionists in England (*Fortnightly Review*, March, 1882), estimates that of one hundred such experiments, there are: —

Absolutely painless	75
As painful as vaccination	20
As painful as the healing of a wound	4
As painful as a surgical operation	1
Total	100

man. But nature's experiments are rarely ever limited in area or uncomplicated; they are never systematic and exhaustive; it takes years to collect a fair number of her clumsy experiments, and the knowledge is diffused through many minds instead of being centered in one that will systematize the results.

Said Ferrier, a year ago, in the Marshall Hall Oration, "There are already signs that we are within measurable distance of the successful treatment by surgery of some of the most distressing and otherwise hopeless forms of intracranial disease, which will vie with the splendid achievements of abdominal surgery."

Note the fulfillment! Last fall, within a year of the foregoing prophecy, a man, aged twenty-five, entered the London Hospital for Epilepsy and Paralysis.[1] From the symptoms, which I need not detail, Dr. Hughes Bennett, basing his conclusions on Ferrier's experiments, diagnosticated a tumor of small size, involving the center of motion for the muscles of the hand. On November 15, 1884, at his instance, Mr. (later Sir Rickman J.) Godlee trephined the skull over the selected spot, and a quarter of an inch *below the surface* of the brain found a tumor as big as a walnut, and removed it. For three weeks the man did well, but died on the thirty-eighth day from blood-poisoning, such as might follow any operation, especially a new one. Macewen, of Glasgow,[2] has similarly trephined a woman, the victim of slow paralysis of body and mind, and opened an abscess a little distance below the surface, letting out two teaspoonfuls of pus, and followed by entire mental and physical recovery.

By these experiments and operations a wide door is open to surgery in the treatment of diseases within the skull — diseases heretofore so obscure and uncertain that we have hardly dared to attack them. The question is not whether

[1] *Medical News*, January 17, 1885.
[2] *Medical News*, January 3, 1885.

death or recovery followed in these particular cases. The great, the startling, the encouraging fact is that, thanks to these experiments, we can now, with well-nigh absolute certainty, diagnosticate, and with the greatest accuracy locate such diseases, and therefore reach them by operation, and treat them successfully.[1] Would that I had been born twenty-five years later, that I might enjoy with you the full luxury of such magnificent life-saving, health-giving discoveries!

It is, however, by the experimental study of the effects of minute organisms — microbes, as they are now called — that some of the latest and most remarkable results have been achieved. The labors of Koch, Pasteur, Klein, Cheyne, Tommasi-Crudeli, Wood, Formad, Sternberg, and others are now known even to the daily press. Let us see what they have done.

It is but three years since Koch announced that consumption was caused by the "bacillus tuberculosis." Later he had studied cholera and found the "comma bacillus," to which he ascribes that dreaded disease. In spite of the opposition of prominent scientists, his views have been in general accepted, and seem to be reasonable. [How odd all these words sound after 30 years!]

The method of experiment is simple, though difficult. The suspected expectoration or discharge is placed in a suitable soil, and after cultivation some of this growth is placed in another culture-soil, and so on till generation after generation is produced, the violence of the poison

[1] In 1899 — only fourteen years after this address was delivered— Knapp collected 491 operations for brain tumors in which the result was known. In 64 operations for palliation — i.e., relief of pain, etc. — only 4 died; in 275 completed operations 82 died (30 per cent); in 152 inoperable and incompleted cases 86 died (56 per cent). (1905.)

A larger experience has developed difficulties unknown thirty years ago, in the exact localization and therefore in the operability of such tumors. But the main fact to be remembered is that before these investigations *every* case of brain tumor was fatal. Hence every case of recovery is one life saved. (1914.)

being modified by each culture. A small portion of any one of these cultures is then injected under the skin of a mouse or other animal, and in time it dies or is killed, and the results are verified by the *post-mortem*.

So exact is the knowledge in tuberculosis now that Koch can predict almost to an hour when the mouse will die of consumption, or that it will escape, according to the culture used.

It is far too early as yet to say that these studies have borne the immense practical fruit that the next few years will show;[1] but they have already enabled us to recognize by the microscope doubtful cases of consumption in their earlier and more remediable stages, and have made certain what has hitherto been only a probability — that consumption is distinctly contagious.

By Gerlach's experiments on animals with the milk from tuberculous cows, also, it has been shown that consumption may be contracted from such milk. How important this conclusion is, in so universal an article of food to young and old, I need not do aught than state.

The experiments of Wood and Formad on diphtheria I have already alluded to. Those of Tommasi-Crudeli also have shown that probably the poison of malaria is due to like organisms, while a large number of other diseases are being similarly investigated.[2]

As to cholera, the classic experiments of Thiersch, in 1853,[3] are well known. He inoculated 56 mice with cholera discharges. Of these, 44 sickened and 14 died from choleraic diseases. In the same year two water companies in London experimented on 500,000 human beings, one of

[1] As a result of this discovery and the methods of sanitation based upon it, the death-rate of tuberculosis has been reduced in various cities by from thirty to fifty per cent. (1914.)

[2] Later experiments by Laveran and others have definitely settled the microbial origin of malaria and also that only one species of mosquito is responsible for the spread of the disease. (1914.)

[3] John Simon, *Proceedings*, International Medical Congress, London, 1881.

them inoculating its patrons with cholera discharges through its impure water-supply. This one sickened thousands and killed 3476 human beings, most of whom might have escaped had the lessons of Thiersch's 14 mice been heeded. To ask the question, which was the more cruel, is to answer it.[1]

At present our strenuous efforts are all in one direction — namely, to study these microbes by the microscope, by clinical observation, and by experiments on animals, in order to find out their origin, causes, growth, and effects, and to discover by what means their deadly results may be avoided, or by what remedies, without harm to the patient, they may themselves be destroyed. Evidently these studies cannot be tried on our patients. They must either be tried on animals or be abandoned.

The inoculation experiments of modern times have recently borne rich fruit in still another pestilential disease — yellow fever — whose ravages in this country are fresh in our minds. November 10, 1884, M. Bouley reported to the Paris Academy of Sciences[2] that, since 1880, M. Freire, of Rio Janeiro, had experimented on guinea-pigs with the virus of yellow fever, and believed that he had been able to produce such attenuation of the virus that by vaccination he could secure immunity from this dreadful scourge. Following the experiments, he and Rabourgeon tested the results on themselves, some students of medicine,

[1] The population supplied by the Southwark and Vauxhall Company, in the epidemic of 1848–49, died at the rate of 118 in each 10,000, and, in that of 1853–54, at the rate of 130 per 10,000. Those supplied by the Lambeth Company died in 1848–49 at the rate of 125 per 10,000, but having improved its water-supply meantime, the death-rate, in 1853–54, fell to 37 per 10,000.

If Thiersch lived in England to-day, he would have to take out a license to kill his fourteen mice in the interests of humanity — a license possibly refused, or only to be obtained after the most vexatious delays. But any housemaid might torture and kill them with arsenic or phosphorus, or Thiersch might give them to a favorite terrier without the slightest interference, provided only it be not for a scientific or a humane object!

[2] *Medical News*, November 29, 1884.

and employees. Later the Emperor Dom Pedro authorized two hundred wharf-laborers to be inoculated. All these, after a three days' mild attack, remained free from the pestilence, while their fellow laborers, similarly exposed to the fever, were dying on every hand. If, in an epidemic, this still prove true, as there seems every probability it will, from the five hundred lives already saved, we can hardly estimate either the medical or the commercial advantages to this country alone. Is this cruelty? Let Norfolk, and Memphis, and Pensacola, and New Orleans answer.[1]

We are all familiar now with the numerous deaths from eating pork infested with trichina. While I was in Berlin, in 1865–66, a terrible epidemic of the then new disease broke out at Hedersleben, a small town in Prussian Saxony. I well remember with what zeal Virchow and his assistants immediately investigated the disease, inoculated animals with the parasitic worm, studied its natural history, found out that heat killed it, and to-day, as a result of these and other experiments, we all know how to avert its dangers by proper cooking, or to avoid it altogether by the microscope. The value of these experiments, both to human life and to commerce, you know even from the daily papers.

You will find it difficult to make the non-medical public understand — nay, you yourselves as yet hardly understand — the enormous advance in medicine and surgery brought about by recent researches on inflammation, and by the use of antiseptics. My own professional life only covers

[1] Since then the brilliant researches of Major Reed, Colonel (now Brigadier-General) Gorgas, and other American army officers in Cuba have shown that the mosquito is the only source of propagation of yellow fever. The cause of yellow fever is still unknown, but mosquito bars guard against the fever, as our knowledge has been augmented, and Cuba and the United States have been freed from this pestilence and its ravages among human beings and its commercial disasters.

So completely has yellow fever been eliminated that since May 17, 1906, — *over eight years!* — not a single case of yellow fever has arisen in the Canal Zone! (1914.)

twenty-three years, yet in that time I have seen our knowledge of inflammation wholly changed, and the practice of surgery so revolutionized that what would have been impossible audacity in 1862 has become ordinary practice in 1885.

It would seem that so old a process as inflammation would long ago have been known through and through, and that nothing new could be adduced. In 1851, however, Claude Bernard, by a slight operation, divided the sympathetic nerve in a rabbit's neck and showed its influence on the caliber of the blood-vessels. In 1858 Virchow published his "Cellular Pathology." In 1867 Cohnheim published his studies on the part that the blood-cells played in inflammation as shown in the frog, followed by further papers by Dr. Norris, of this city, Stricker, Von Recklinghausen, Waldeyer, and many others. Already in my lectures I have pointed out to you in detail the advances made by these studies, both in theory and practice. They have brought about an entire reinvestigation of disease, and given us wholly new knowledge as to abscesses, ulceration, gangrene, the organization of clots in wounds, and after operations and ligature of blood-vessels for aneurism, as to thrombosis, and embolism, and paralysis, and apoplexy, and a score of other diseases through the diagnosis and treatment of which now runs the silver thread of knowledge instead of ignorance.

With this the brilliant results of the antiseptic system have joined to give us a new surgery. Sir Joseph (later Lord) Lister, to whom we chiefly owe this knowledge, has done more to save human life and diminish human suffering than any other man of the last fifty years. Had he only made practicable the use of animal ligatures, it would have been an untold boon, the value of which can only be appreciated by doctors; but he has done far more, he has founded a new system of surgery. We may reject the spray and carbolic acid, but the surgical world, regardless of details, with few

exceptions follows the principles upon which his method is founded and humanity is the gainer, by the nearly total abolition of inflammation, suppuration, secondary hemorrhage, blood-poisoning, gangrene, erysipelas, lockjaw, and "hospital gangrene," as sequels of accidents and operations; by the relief from suffering and death, by operations formerly impossible; by rendering amputations and compound fractures safe and simple instead of deadly. Reflect on what each one of these brief, but momentous, statements means![1]

But we have by no means reached perfection. Lister himself, no tyro, but the great master, is still searching for further improvements. But when lately he desired to make some experiments on animals, still further to perfect our practice, so many obstructions were thrown in his way in England that he was driven to Toulouse to pursue his humane researches.

I had intended also to speak of many other practical benefits to man directly, but can only mention such important matters as the surgery of the thyroid gland, the seat of goiter; the surgery of the lungs, parts of which have been removed; the surgery of the nerves; removal of the entire larynx; the remarkable researches of late years as to the periosteum in the reproduction of new bone after removal of dead or diseased bone; Bernard's important observations as to diabetes; Brown-Séquard's experiments on epilepsy; the modern extraordinary advance in nearly all the diseases of the nervous system, and a number of other discoveries, as to all of which experiments upon animals have added largely to our knowledge, and therefore to our means of diminishing suffering and saving human life. For many of these, as well as for the most judicial discussion of the vivisection question I have yet seen, I must refer you to that remarkable book, "Physiological Cruelty."[2]

[1] These splendid results are described in later papers in this volume.

[2] See also the *Life and Labors of Pasteur*, by Vallery-Radot.

I had also intended to refer in detail to the splendid results of vivisection in relieving the sufferings of animals, and in preventing enormous pecuniary loss to man. We are only beginning to see that vivisection is as humane to animal life and suffering as it is to human, and that for financial reasons as well as humane motives it is of the utmost importance to the State that such diseases as cattle plague, splenic fever, chicken cholera, swine plague, and others, should be eradicated. Vivisection has shown us how this may be done, and has so conferred upon animals, too, the boon of life and health. For all this, however, I must refer you to the recent admirable lecture by Professor Robert Meade Smith, of the University of Pennsylvania.[1]

One subject, however, is so recent and of such interest, both to man and animals, that I must not pass it over—I mean that justly dreaded disease hydrophobia. Thanks to vivisection, its abolition in the near future seems no longer to be a matter of doubt.

Within the last three years Pasteur has announced that, by passing the virus through the monkey, he has been able to protect dogs from hydrophobia by vaccination with this weakened virus. The French Government recently appointed an eminent scientific commission to report on the alleged discovery.[2] Pasteur furnished them with 23 vaccinated dogs. These 23, and 19 others unprotected, were all inoculated from rabid animals. Of the 19 unprotected, 14 died. Of the 23 protected dogs, 1 died of diarrhea, and all the others escaped. It has yet to be tried on a man suffering from hydrophobia, but, should our reasonable hopes be realized, what a boon it will be![3]

[1] *Therapeutic Gazette*, November, 1884.

[2] *Medical News*, August 30, 1884.

[3] "Pasteur Institutes" for the treatment of hydrophobia and some similar diseases have been established in nearly every civilized country in the world. Of persons bitten by animals believed to be rabid, heretofore about sixteen per cent developed hydrophobia, and *every one* died. In the thousands of such cases treated by Pasteur's method even those bitten by animals *known* to be rabid the mortality is *less than one per cent.* (1914.)

With this brief summary of a few of the recent practical benefits from vivisection, I must close. I have given you only ascertained facts for your future use in the communities in which you may settle. They may assist you in forming public sentiment on a basis of fact, of reason, and of common sense. The sentiment of our own profession, so constantly and so conspicuously humane, is always against inflicting pain; but if in yielding to sentiment we actually increase disease, and pain, and death, both among animals and men, our aversion to present pain is both unwise and actually cruel.

RECENT PROGRESS IN SURGERY[1]

In no department of medicine has there been more rapid and in many respects more astonishing progress in recent years than in surgery. This progress is due chiefly to two things — the introduction of antiseptic methods, and to what we have learned from laboratory work and experiments upon animals.

It has long been known that a "simple" fracture, in which the skin is unbroken, and a "compound" fracture, in which the skin is broken and the air has easy access to the fractured bone, were vastly different in their dangers; but *why* the communication with the air was so dangerous was a mystery. Of late years, however, the germs existing in the atmosphere, and on every material coming into contact with the wound, such as dirty clothing, ordinarily clean instruments, the skin of the patient, the hands of the surgeon, and the dressings, have been investigated by a large number of observers, and it has been abundantly proved that infection comes not from the wound itself, but from the exterior, and that this infection from without is the cause of inflammation and of its speedy sequel, the formation of "pus" (that is, "matter"). Once that the pus begins to form, fever, abscesses, blood-poisoning, gangrene, erysipelas, one or all, may start up into ominous and fatal activity. Inflammation and suppuration (that is, the formation of pus), then, are the causes of all these evil processes. They are all called briefly "septic" (that is, "poisonous") processes. Hence "antiseptic" methods are those that prevent inflammation and suppuration.

Now we see why a compound fracture, or any other

[1] Reprinted from *Harper's Magazine*, October, 1889, by the kind consent of Messrs. Harper & Brothers.

"open" wound (that is, one in which the protective defense of the skin is destroyed), is so much more dangerous than a simple fracture, or a subcutaneous wound. It arises from the fact that these septic germs, or "microbes," have easy access to the tissues, and, once there, multiply with almost incredible rapidity, and quickly set up inflammation and suppuration and their consequences. At first it was thought that the chief danger lay in atmospheric germs, but later investigations have proved that the skin of the patient, and especially the hands of the surgeon, and his instruments and sponges, and even his dressings, are far more frequent sources of infection.

Perhaps I cannot better illustrate the difference between the old, or "septic," and the new, or "antiseptic," surgery than by describing two amputations, one such as was commonly done, for instance, during the Civil War, and the other such as is done now by every good surgeon. In fact, it is only within the last ten or fifteen years that antiseptic surgery has become generalized in the profession.

Let us suppose an amputation above the elbow, and the operator the best surgeon of the Civil War. The arm was not specially prepared, except that it would be cleaned of its coarse dirt arising from the accident, but that would be all. The instruments were taken out of an ordinary case and placed on a table, and during the operation were frequently placed upon the patient's clothing, soiled often by the accident necessitating the operation, as well as by more or less wearing. If the instruments or sponges fell upon the floor, they would be picked up, dipped into water, and then used with innocent equanimity. The sponges, washed and dried from the last operation, were simply thrown into a basin of ordinary water. The hands of the surgeon were as clean as a gentleman would always keep his hands. The amputation having been done, the arteries were tied with silk threads (called "ligatures"), one end of each being left long. These long ends were left hanging out of the wound

at any convenient place, and in an amputation of a muscular thigh might number a score or more. Hemorrhage having been checked, the two flaps were sewed together with wire or silk threads, called "sutures." In threading the needle, the silk thread would often be shaped into a point by the lips, or, after being wetted with septic saliva, would be rolled between septic fingers. A piece of lint, or often a piece of soft, old linen "rag," spread with some grease, was placed upon the stump, and a suitable bandage applied. The next day the dressings were removed, and the wound was redressed in a similar manner. At the end of twenty-four or forty-eight hours a fever would set in, called in our textbooks "surgical fever," thus assuming that a surgical operation always resulted in such a fever; nor was the assumption erroneous at that time. This would continue for several days, the temperature ranging from 102° to 104° or 105° F. In a few days, when suppuration became established (and this was *always* expected by the surgeon), the fever would gradually subside, and later the suppuration also would diminish. At the end of a week or ten days the surgeon would pull gently on each silk ligature, to see if it had rotted loose from the blood-vessel and could be removed. If the wound became unduly inflamed, poultices would be applied; and finally, after three or four weeks, the ligatures would all have been removed, and the wound soon be healed. Very rarely, indeed, would a wound heal without suppuration. If it did, it always excited remark, and would be recounted as a surgical triumph. Very often, on the other hand, grave complications arose by the formation of abscesses; erysipelas and gangrene were fertile sources of danger, and very often of death; while secondary hemorrhage—that is, hemorrhage following premature rotting of the ligatures on the blood-vessels—was always a possible, and frequently an actual and formidable, danger to life. A serious operation from which the patient recovered in less than a month was a "remarkable case."

Contrast this with a similar operation performed to-day by any ordinarily well-instructed surgeon. The day beforehand the skin in a wide area around the site of the proposed operation will first be scrubbed by a nail-brush with soap and water, then with ether, then with some antiseptic solution, — most frequently at the present day a solution of corrosive sublimate, one part to one thousand of water, — and then covered with an antiseptic dressing until the operation is begun. The object of this is to free the skin from dirt and fatty matter, making it *surgically* clean and free from germs. The instruments will have been boiled in a covered vessel for fifteen minutes, or disinfected by carbolic acid or some equivalent germicide, and are then placed in a tray filled with an antiseptic solution. In the cleaning of them after the last operation all rough and more or less inaccessible places where germs may accumulate (especially, for instance, the joints) will have been scrupulously disinfected. If during the operation an instrument is laid down, it is never placed on the clothing of the patient, but either is replaced in the tray, or laid upon towels or sheets which have been disinfected and spread all over the patient's person and clothing all around the field of operation.

After an operation the sponges are thrown away if they have become infected from pus; but if not, they are very carefully disinfected, and then kept permanently in a carbolic solution.[1] At the next operation they are placed in a tray containing some antiseptic, or at least water which has been boiled, for heat has been found to be one of the best antiseptics. If a sponge or an instrument fall on the floor, it is laid aside, or before being used again is thoroughly disinfected. The hands of the surgeon will next receive especial care. First they are scrubbed with soap and water and a nail-brush. Then the nails are cleaned anew, for the

[1] Later gauze "sponges" have practically displaced these "marine" sponges.

dirt which accumulates under them is found to be one of the most fruitful sources of infection. Then the hands are washed in pure alcohol, and last, while wet, are again scrubbed with the antiseptic solution, the nails again receiving great care. If during the operation the hands touch anything not itself already disinfected, they must again be disinfected.

These precautions being complete, the operation is begun. The blood-vessels are tied with catgut or silk which has been disinfected, and *both* ends are cut *short*. These ligatures are not irritating like the non-disinfected silk formerly used. As no end hangs out, they are never pulled upon, but are slowly absorbed, and nothing is ever heard of them again. In consequence of this the blood-vessels are never afterward disturbed, and secondary hemorrhage is now one of the rarest complications following an operation. A disinfected rubber tube, with holes in it for draining away the wound fluids, which ooze from the raw surfaces for some time, is then inserted between the flaps, with a bundle of horse-hairs alongside of it. The flaps are now united by sutures of catgut, disinfected as before, or sutures of wire or of silk similarly prepared. A large, soft dressing of many layers of dry cheese-cloth is next applied by a bandage. This dressing has been thoroughly impregnated with corrosive sublimate or some other antiseptic solution. The finest linen or lint, clean as the driven snow to the ordinary eye, is dirty to the eye of an antiseptic surgeon, since it is not cleansed from the microscopical germs that will surely cause infection. At the end of twenty-four hours the drainage tube is removed, the horse-hairs being sufficient for the slight later drainage, and another similar dressing of dry antiseptic cheese-cloth is applied. The horse-hairs are entirely removed after four or five days.[1]

The temperature of the patient after the operation

[1] Since 1889 this "ritual" has been much simplified and at the same time is more efficient. (1914.)

scarcely rises above the normal. Apart from the discomfort of the ether-vomiting, from shock, and from loss of blood (from all of which the patient generally recovers in twenty-four hours or less), he will suffer but little pain. It is not an infrequent thing to see a patient recover, even from a severe operation, without having suffered much pain. By the fifth or the tenth day, when the second dressing will be applied, the wound is well. No complications ought to occur, saving in exceptional cases. Secondary hemorrhage is unknown. Primary union of the flaps is now always expected. The formation of pus is a rare accident; if it does occur, the surgeon asks himself, "What mistake did I make?"

Let us now see what the results have been in amputations. In Professor Billroth's clinic in Vienna, in the seventeen years from 1860 to 1877, there were 315 major amputations done (i.e., excluding fingers and toes) in the most approved methods of the days before antiseptics were introduced. Of these, 173, or 54 per cent, died. From 1877 to 1880, 91 such amputations were done by the same surgeon with antiseptic precautions, and the mortality fell to 18, that is, 19.7 per cent — nearly one third of the former rate. Of the 91 cases, 56 were uncomplicated cases, of whom not one died. The general rates of mortality in amputations in different hospitals in the days before antiseptics were employed have ranged from 23 to over 53 per cent. Since the introduction of antiseptics some idea of the saving of life, to say nothing of the immense decrease of pain and suffering, may be gathered from the following additional figures: In Von Brun's clinic, 47 major amputations were done antiseptically, and not one died. Busch reports 57 similar amputations, with a mortality of 3.5 per cent; Schede, 31 amputations with a mortality of 4.37 per cent; Socin, 48 amputations, and a mortality of zero; and Volkmann, 220 amputations, with a mortality of but 3.5 per cent. I have purposely quoted the statistics of six

operators so as to show that it is not the man, but the method, which has yielded such splendid results.

This perfection has been reached by an immense deal of labor on the part of many observers, first and foremost, *primus inter pares*, Sir Joseph (later Lord) Lister, now of London. The experiments have been made chiefly in two directions. First, on animals, to discover what was the best method of treating wounds, and especially to select the best material for ligatures and sutures by which to tie the bleeding vessels and unite the flaps, the object being to obtain that material which would not carry infection, and which, at an early date, would be entirely absorbed — yet not at *too* early a date lest the blood-vessels should not be firmly closed and therefore secondary hemorrhage should occur. These experiments upon animals have been attended with but little pain, and in many cases practically none, for they, too, have been done antiseptically. The results shown above attest the immense value of the investigations. Yet the antivivisection laws in England are so hostile to all humane progress in surgery that when, a few years since, Lister desired to carry on some experiments with a view to still greater perfection, he was obliged to leave London and go to France in order to perform them. After experimenting in animals with ligatures, with sutures, and with disinfectants in the various modes of the antiseptic treatment of wounds, then followed the crucial test in man — a test only justified by the good results first obtained in animals. These trials have from time to time been followed by modifications in detail, but practically none in principle.

Secondly, this result has been attained by a painstaking study of the entire life-history of the many varieties of microbes or bacteria now known to exist: what distinguishes one from another, and what favors and what hinders the development of each. Next the effects of their intentional inoculation in animals were observed; and then the results

of their occurrence in man in various diseases and accidents. In fact, this study of bacteria is now a distinct science, known as bacteriology, and has among its students some of the most noted names in medicine. One of the practical results of such scientific study of bacteriology is seen in the recent immense improvement of our treatment of that dangerous accident already alluded to — compound fractures. The statistics of compound fractures from a half-dozen of the best hospitals of America and Europe for varying periods from twelve to twenty years before the introduction of antiseptic methods gave a mortality varying from 26 to 68 per cent, the majority of deaths being from serious complications due to blood-poisoning. The introduction of antiseptics caused a falling-off of the death-rate of Billroth's cases in Vienna to *one tenth* of what it formerly was, and in the other hospitals in similar though varying proportions. Still more remarkable are the results recently reported by Dennis of New York. Of 446 compound fractures of all grades, from the most severe down, of which 385 belonged to the class of severe fractures, only 2 died, the mortality being less than *one half of one per cent* — less than 2 in 400 in contrast to the rate previous to the introduction of modern surgical methods of from 104 up to 272 in 400! At present his list of cases extends to about 900 without a single death from blood-poisoning. Nothing can add force to such a statement.

Besides these very remarkable results in the almost certain and painless healing of severe accidents and of operation wounds within the last few years, as a result of the scientific studies just noted, many other achievements have been made possible by them in modern surgery, to which I must now allude.

The two regions of the body in which the most marvelous advance has been made are the abdomen and the head. Twenty-five years ago, to open the cavity of the abdomen and explore the peritoneum (a thin membrane which lines

the entire cavity and covers all its contents) was a step from which every prudent surgeon shrunk. If it were opened by accident, there was nothing left for us but to do the best we could, and usually the best meant, in the absence of antiseptic methods, to look on until the patient died, helpless to do aught except administer a few anodynes until death came to his relief.

During the War of the Rebellion there were 64 cases of wounds of the stomach, and only 1 recovered. Otis estimated the mortality at 99 per cent. In over 650 cases of wounds of the intestines there are recorded in the literature of the war only 5 cases of recovery from wounds of the small intestine (and there is even some doubt as to whether the intestine was really wounded in these 5) and 59 from wounds of the large intestine. A gunshot wound in the abdomen was looked upon as almost necessarily fatal. Surgeons scarcely dared to open the abdomen either to search for the ball, to close a fatal perforation of the bowels, or to check hemorrhage.

America can rightly boast of playing the chief rôle in effecting the change that has taken place. The elder Gross long since led the way by his experiments on dogs, but we owe our present boldness and success chiefly to the experiments of Parkes, Bull, and Senn, — all Americans, — who have first shown in animals that it was safe and right, with antiseptic methods, to interfere actively for the health and healing of our patients. While it is true that a small rear-guard in the surgical army would fold their hands and give opium until the patient died, there is scarcely a man abreast with modern ideas who in such a case would not open the abdomen, tie bleeding vessels, sew up a rupture or wound of the stomach or bowels, remove a lacerated kidney, and in general repair any damage done. Of course, large numbers of such patients, either from immediate hemorrhage, or from the severity of the wound inflicted, must always die. But, to say nothing of the numerous other cases in

which recovery has followed operative interference in such wounds, even though multiple, the possibilities of modern surgery are well shown in a case reported by Senn, in which eleven perforations of the bowel were sewed up, and another case of Hamilton's in which there was so extraordinary a number as thirteen wounds of the intestines, besides wounds of the omentum and the mesentery, and yet both of these patients made uninterrupted recoveries! In a recent table by Morton of 19 cases of stab wounds (all, of course, by dirty knives, and one even by a ragged splinter of dirty wood) with hemorrhage and protrusion of the bowels, 12 recovered and but 7 died, and even of 110 gunshot wounds of the intestines in which the abdomen was opened, 36 lives were saved.[1]

If this be the admirable showing in wounds attended by infection from dirty knives, from the dirt on the clothing, and from the ground on which wounded persons would fall, it is no wonder that, with clean hands and instruments, surgeons have dared not only to open the abdominal cavity to verify a probable diagnosis, or to perform an operation, but to go still farther and to open the abdomen to *make* a diagnosis. It is often impossible to make an absolute diagnosis from external examination alone, not only on account of the inherent difficulty from the close grouping of so many organs within the abdominal cavity, but even in cases apparently not obscure we may be in error. At the present day it is not only considered justifiable and not unreasonably dangerous to open the abdomen for the removal of tumors that are clearly fit for operation, but in a very large number of doubtful cases it is the *duty* of the surgeon to make a small opening directly into the abdominal cavity, and to insert two fingers in order to determine by touch what the nature of the tumor or other disorder is, and,

[1] Keyes, *Journal American Medical Association*, November 23, 1912; p. 1886, records a recovery after twenty-two gunshot perforations of the bowel!

having determined its nature, to proceed to its removal, if the facts warrant it; if not, the abdominal wound is closed, and the patient practically always recovers from the incision. So slight is the danger from such "exploratory operations," as they are rightly called, that it is not to be weighed for a moment against the advantages derived from positive knowledge.

The most remarkable statistics recently published are those of Mr. Tait, and a mere statement of his percentages will go far to convince the non-medical public of the correctness of the above statements, startling as they appear to one unfamiliar with modern surgical progress. Mr. Tait has completed a second series of 1000 cases in which he opened the abdomen for the removal of tumors, for abscesses, for exploration, etc. In his first 1000 cases only 92 patients died (9.2 per cent), and in the second 1000 only 53 died (5.3 per cent). In ovariotomy alone the percentage fell from 8.1 in the first 1000 to 3.3 in the second. Only a quarter of a century ago the mortality of ovariotomy was but little, if at all, under 50 per cent. I have heard the first obstetrician of his day, when I was a student, say that any man who dared to open the abdomen to remove an ovarian tumor should be indicted for murder! Sir Spencer Wells, even with the far larger mortality of his earlier days, added twenty thousand years to human life as the net result of one thousand ovariotomies! He has lived to see even his great success far surpassed by the best surgeons; and all over the civilized world, even the average surgeon is followed by benedictions for recovery in ninety out of every hundred of such operations.

Surgeons have even successfully removed tumors that after removal weighed more than all the rest of the patient's body. But we go further than the mere removal of abdominal tumors. In a considerable number of cases of cancer of the stomach the diseased part of the stomach itself has been removed, and the patient has made a good

recovery. Of course, however, the disease often returns, and is eventually fatal. In cases of cancer and obstruction of the bowels, or of extensive wounds, even three or four feet of the bowel have been completely removed, the ends sewed together, and the patients have recovered. In other cases, instead of removing the diseased parts, openings have been made in the bowel, one above and one below the disease, the two openings being then placed opposite each other and united by their margins, and the continuity of the bowel has been thus successfully reëstablished, the intestinal contents following the "short-cut" thus provided. This very new operation has only been done in man in a very small number of cases, but the mortality in dogs is only 7.69 per cent, and as our procedure will improve by experience, it will probably be even less in the human subject.

When the spleen is enlarged, it also has been successfully removed in 90 cases, followed by 51 recoveries. Occasionally the spleen, instead of being fixed in its place, is loose or "floating" in the abdominal cavity. In 10 cases these have been removed, with 8 recoveries.

Another remarkable achievement of abdominal surgery is in operations on the gall-bladder. Occasionally a number of gall-stones[1] are formed in the gall-bladder or its duct and produce dangerous and often fatal disease. In 78 cases now recorded the gall-bladder has been opened, the gall-stones removed, and 64 of the patients have recovered. Not satisfied even with this, in 22 cases the entire gall-bladder itself has been removed to prevent any recurrence of the disease, and 19 of the patients have demonstrated the fact that they could get along quite as well without such an apparently useless appendage as with it; in fact, in their cases at least, a good deal better. In 100 operations, therefore, on the gall-bladder the mortality has been only

[1] These stones arise from the bile, and are often as large as marbles. Sometimes only one exists, but sometimes there are even hundreds of them.

17 per cent. Mr. Tait himself has performed 54 such operations, and has lost but 2 patients, a mortality of less than 4 per cent. Considerable portions of the liver have also been removed with success, one of the operations being necessitated as a direct result of the use of corsets, in the opinion of the operator.[1]

Operations on the kidney are among the most remarkable triumphs of abdominal surgery. In 1869 Simon, of Heidelberg, had a patient suffering from various troubles with the duct of the kidney. After many experiments on dogs to determine whether it was possible for them to live with one kidney, after the sudden removal of its fellow, he ventured to remove this otherwise healthy organ, and the patient lived for eight years in perfect health.[2] Since then very many such operations have been done, and the latest results are as follows: In 375 cases of entire removal of one kidney in consequence of its being hopelessly diseased, 197 lives were saved. In 95 cases of abscesses and other diseases, in which the kidney was cut down upon in the loin or abdomen, and the kidney opened and drained, 76 lives were saved. In 102 cases in which stones were removed from the kidney, 76 lives were saved, and in 25 cases in which the kidney (as in the case of the spleen above referred to) was "floating" around loose in the abdomen, and a source of discomfort and pain, it had been cut down upon, sewed fast in its proper place, and all but one got well, and even this one death was from injudicious surgery. A total of 597 operations on the kidney shows, therefore, recovery and, in general, complete restoration to health in 373. Had the patients been let alone (as they would have been prior to Simon's experiments in 1869), *almost every one would have died*, and that, too, after weeks, or years it might be, of horrible pain and loathsome disease.

[1] The statistics of all these operations have been greatly bettered in the twenty-five years since this was written. (1914.)

[2] See pp. 10–12.

But the most extraordinary achievement of modern surgery remains to be told. In the "Lancet" for December 20, 1884, Dr. Bennett and Mr. (later Sir Rickman J.) Godlee published an article which startled the surgical world. Dr. Bennett had diagnosticated not only the existence, but the exact locality of a tumor in the brain, of which not the least visible evidence existed on the exterior of the skull, and asked Godlee to attempt its removal. The head was opened and the brain exposed. No tumor was seen, but so certain were they of the diagnosis that Godlee boldly cut open the healthy brain and discovered the tumor the size of a walnut and removed it. After doing well for three weeks, inflammation set in, and the patient died on the thirty-eighth day. But, like the failure of the first Atlantic cable, it pointed the way to success, and now there have been twenty tumors removed from the brain, of which seventeen have been removed from the cerebrum with thirteen recoveries, and three from the more dangerous region of the cerebellum, all of which proved fatal. Until this recent innovation *every* case of tumor of the brain was absolutely hopeless. The size of the tumors successfully removed has added to the astonishment with which surgeons view the fact of their ability to remove them at all. Tumors measuring as much as three and four inches in diameter and weighing from a quarter to over a third of a pound have been removed and the patients have recovered.

Another disease formerly almost invariably fatal is abscess of the brain. In the majority of cases this comes as a result of long-standing disease of the ear, which after a while, involves the bone and finally the brain. So long ago as 1879 Dr. (later Sir William) Macewen, of Glasgow, diagnosticated an abscess in the brain, and wished to operate upon it. The parents declined the operation, and the patient died. After death Macewen operated precisely as he would have done during life, found the abscess and evacu-

ated the pus, thus showing how he could probably have saved the child's life. Since then the cases treated in such a manner amount to scores, and more than half of them have recovered without a bad symptom.

In injuries of the skull involving the brain, the larger arteries are sometimes wounded, and the blood that is poured out between the skull and the brain produces such pressure as to be speedily fatal. In some cases, even without any wound, the larger arteries are ruptured by a blow or fall, and a similar result follows the hemorrhage. Nowadays, in both of these injuries, any well-instructed surgeon will open the head, secure the bleeding vessel, and turn out the clot with a good chance of recovery in a large number of cases. Even gunshot wounds of the brain are no longer necessarily fatal. Among a number of other successful cases one has been recently reported in which the ball went all the way from the forehead to the back of the head, and after striking the bone rebounded into the brain. The back of the skull was opened, the ball removed, and a rubber drainage tube of the caliber of a lead pencil passed in the track of the ball completely through the head, and the patient recovered. So little danger now attaches to opening the skull, with antiseptic precautions similar to those already described, that the latest writer on trephining (Seydel) estimates that trephining *per se* is fatal only in 1.6 per cent of the cases. Mr. (later Sir Victor) Horsley has recently published a most remarkable paper, including ten operations on the brain, in which, without anything on the exterior to indicate its situation, the site of the disease was correctly located in all, and nine of them recovered after operation.

Almost equally astonishing are the results of brain surgery in certain cases of epilepsy; for the surgical treatment of the cases justifying such interference has been attended with the most brilliant results. In these cases the spasm begins in a particular part of the body; for example,

the hand or the thumb, or it is limited to one arm, or to one side of the body. Some of them have been operated upon without any benefit, but a large number of other cases have been operated on and either benefited or, in not a few cases, have been completely restored to health. That the words "brilliant results" are not inappropriate will certainly be granted when we look at Horsley's table of cases. One patient had 2870 epileptic convulsions in thirteen days, and completely recovered, not only from the operation, but also from his terrible malady, after the removal of a diseased portion of the brain, the result of an old depressed fracture of the skull. Besides this, a few cases of headache so inveterate as to make ordinary occupations impossible and life itself a burden have been cured by trephining the skull. Even insanity itself has been cured by such an operation in cases in which it has followed injuries to the head. What the ultimate result of these recently inaugurated operations will be it is impossible to tell as yet, but thus far they have been so beneficent and so wonderful as to arouse not only our greatest astonishment, but also our most sanguine hopes.[1]

The question will naturally arise, how is it that the neurologists can determine so exactly the location of such tumors, abscesses, hemorrhages, scars, and other alterations of tissue giving rise to epilepsy and other disorders mentioned, without the slightest indication on the exterior of the skull to point to the diseased spot. That this is of supreme importance in the brain will be evident upon a moment's reflection. In other parts of the body, even if we make an error of an inch or two, it is of comparatively little importance, as the incision can be easily prolonged, and heals readily. But in the skull, from the very nature of the bony envelope, an error of an inch or two means almost

[1] Larger and longer experience has modified these expectations. Most cases of epilepsy are not amenable to operation, but in many cases the result has been "brilliant." (1914.)

certain failure to find the disease, and means, therefore, possibly the death of the patient.

It is impossible within the limit of this paper to state in detail the method, but the following brief sketch may give some idea of it. Whatever can be advanced against vivisection, there is this to be said in its favor, that without it the exact localization of cerebral tumors and other such lesions, which is one of the chief glories of the present day, would be impossible. We owe our knowledge of the location of cerebral functions to many observers, chief of whom are Ferrier and Horsley, of England, and Fritsch, Hitzig, and Goltz, of Germany. Horsley's method will suffice as a type.

The brain of a monkey having been exposed at the part to be investigated, the poles of a battery are applied over squares one twelfth of an inch in diameter, and all the various movements which occur (if any) are minutely studied. One square having been studied, the next is stimulated, and the results are again noted, and so on from square to square. These movements are then tabulated. For example, all those adjacent squares which, when stimulated, produce movements of the thumb are called the region for representation of the thumb, or, shortly, "the thumb center"; and to all those squares which produce movements of the hand, the elbow, the shoulder, or the face, etc., are given corresponding names. In this way the brain has been mapped out, region by region, and the same minute, patient study given to each.

These animals, I should add, are etherized so that they do not suffer the least pain. I may also say in passing that such operations[1] with few exceptions, even without ether, are not painful. The brain itself can be handled, com-

[1] Operations on the brain itself were meant. Of course the incision in the scalp would be very painful and would require an anesthetic. Handling, cutting, and even burning the brain tissue (as is occasionally necessary to check hemorrhage), it must be emphasized *produces not the least pain.* I have had patients chat and joke with me while doing so. (1914.)

pressed, cut, or torn without the least pain. A number of cases have already been reported in which a considerable portion of the human brain has been removed by operation and the patients have been out on the street within a week, without pain, fever, or a single dose of medicine.

Studying in this way the brain of the lower animals, we now have a very fair knowledge of the localization of many of its functions. With the functions of the front part we are as yet not familiar. The part which lies, roughly speaking, behind and in front of one of the chief fissures of the brain (the fissure of Rolando), which runs downward and forward above the ear, is known as the "motor region." In this region the different centers have been mapped out in the monkey's brain, and have been verified in the brain of man many times. Most of that part of the brain above and behind the ear has no special functions that we know of at present, except one region, which is the center for sight. Injury to this produces blindness of the half of each retina on the same side as the injury to the brain. But it is extremely difficult to obtain in the lower animals any evidence of the special senses other than that of touch, the abolition of which produces loss of feeling, of which we can get exact evidence. Motion and sensation, therefore, are the two things that can be most readily determined.

Having now ascertained in animals the location of the particular centers, the next step is to apply this knowledge to the human brain in judging of the processes of disease. But it will be easily seen that the experiments that disease performs in a human brain are clumsy, spread over a wide area, and therefore often difficult of interpretation. Instances affecting a single little area of brain surface one twelfth of an inch in diameter are almost unknown, and a tumor has been removed of such size that it produced direct pressure upon more than *twelve hundred* such squares, and indirectly produced pressure upon many distant parts of the brain. This is, of course, very clumsy experimentation.

The familiar game of "shouting proverbs" will well illustrate the difficulty of interpreting the answers of disease to our question, "Where is it located?" Imagine twelve hundred persons, each assigned a single word of a proverb of twelve hundred words. At a given signal each shouts his own word. What a Babel of sound! How utterly impossible of disentanglement and proper arrangement! This is the answer of disease as represented by such a tumor. Take each of the twelve hundred persons in the proper order and question him separately and repeatedly, write down the answers accurately and in their proper sequence, and behold the proverb! This is the answer of scientific investigation as seen in vivisection.

Instead of there being a tumor, a blood-vessel will sometimes break in the brain, and produce a clot, affecting similarly a large area; or softening of the brain will in the same way invade an equal or a greater number of centers. It is therefore extremely rare that we can find a small area, such as that for speech, or for the hand, or for the arm, or for the face, or for the leg, or for sight, that is involved entirely by itself. But such cases do occasionally occur, and they are extremely valuable in fortifying the conclusions derived from the exact experiments of the laboratory. While some of the cases have introduced confusion and uncertainty from the character of nature's experiments, it can be broadly asserted that generally they have absolutely confirmed them. The results obtained by the surgery of the brain have more than confirmed them; for, as indicated already, the brain has been exposed, and that portion which, according to experiment, is believed to be the center for the wrist, or for the shoulder, etc., has been cut out, and paralysis of the corresponding part (a paralysis which, however, is usually only temporary) has proved positively the accuracy of the inference from animals.

We are still a little uncertain as to the exact functions of large portions of the brain, but we have made a reasonable

beginning; we have found firm ground to stand upon, and the results already obtained in the relief of human suffering and the cure of disease are such as readily encourage the hope that in the near future we shall be able to do vastly more. The opponents of vivisection have stoutly contended that it has shown no useful results. Let us wholly ignore the researches of Sir Charles Bell, of Harvey or Hunter, or other experimenters of the past. Here is a field in which the last ten years have opened wholly new ground for modern surgery, in which already the operations of the last four years have been marvelously successful, and have startled even surgeons themselves. Had vivisection done nothing else than this, it would be amply justified, and to obstruct researches so rich in beneficent results would be a disaster to humanity.

But not only has the brain been exposed and compelled to give up its secrets, and to yield itself to the successful assaults of the surgeon, — the spine has also of late been the field of some remarkable work. About a year ago Horsley reported a remarkable case, in which a tumor by pressure on the spinal cord had been the source of most frightful pain for a long time, and of paralysis of all the lower half of the body. Once that an accurate diagnosis, not only of its existence, but of its actual locality was made, he made an incision in the back, exposing the backbone, cut away the bone down to the membrane, and even to the spinal marrow itself, and removed the tumor. When last reported the patient was able to walk three miles, and even to dance. Since then there have been numerous successful operations upon the spine in this country, in England, and in France, and the near future will doubtless show even better results. Already severe fractures of the spine have been operated upon by removal of the fragments sticking into the spinal marrow, and recovery has followed instead of a lingering and certain death.

We are only just beginning to interfere surgically with

the lungs; to open abseesses in them, and to remove portions successfully; and several ribs have been removed in cases of chronic pleurisy and deformed chests.

Formerly one of the most dangerous operations known was the removal of goiters. Hemorrhage, inflammation, and blood-poisoning destroyed a very large number of such cases, and when Kocher, of Berne, in 1882, reported 58 operations, with a mortality of only 14.3 per cent, it was deemed a triumph. But improved methods of operation reduced the mortality until, in 1884, he reported 43 more operations, with a mortality of only 6.9 per cent, and in 1889 he has just reported 250 additional operations, and all but 6 patients recovered — a mortality of but 2.4 per cent, or, if we exclude the 25 cases of cancer, which gave 4 of the deaths, we have 225 cases and only 2 deaths, a mortality of but 0.8 per cent.[1]

We see few cases of severe knock-knee and bowlegs in this country, but among the ill-fed lower classes of Europe they are common. Formerly almost nothing could be done; but a few years ago surgeons began to operate upon them in this way: A small cut is made through the skin and muscles down to the bone, and by a saw or a chisel the bone is divided. The limb is then straightened, and the case treated precisely as if it were an ordinary fracture. It heals without fever or serious pain, and the patient is well. With modern methods this is not a dangerous operation, as will be seen by the remarkable paper read by Macewen, of Glasgow, at the International Medical Congress of 1884, in Copenhagen, when he reported 1800 operations on 1267 limbs in 704 patients, and only 5 died, in spite of the fact, too, that most of them, from deformity in several limbs, had to have multiple operations. Even these deaths were

[1] Charles H. Mayo, in 1913, reported five thousand cases (including all varieties) of goiter operated on in the Mayo clinic in twenty-five years, with a mortality of only one to three per cent. (*Journal of the American Medical Association*, July 5, 1913.)

not due to the operation, but followed from pneumonia, typhoid fever, consumption, and diphtheria.

We have learned, too, that portions of the body can be entirely severed, and, if suitably preserved, can be replaced, and they will adhere and grow as if nothing had happened. When a wound is slow in healing, we now take bits of skin, either from the patient's own body or provided by generous friends, or even from frogs, and "graft" them on the surface of the wound. They usually adhere, and as they enlarge at their margins, they abridge by one-half the time required for healing. Even a large disk of bone, one or two inches in diameter, when removed from the skull, can be so treated. It is placed in a cup filled with a warm, antiseptic solution. This cup is placed in a basin of warm water, and it is the duty of one assistant to see that the thermometer in this basin shall always mark 100° to 105° F. The bone may be separated from the skull so long as one or two hours, but, if properly cared for, can be replaced, and will grow fast and fulfill its accustomed, but interrupted, duty of protecting the brain.[1]

The remarkable progress of surgery which I have so imperfectly sketched above has been, as I have shown, the result chiefly of experimental laboratory work. To Mr. Carnegie, of New York, is due the credit of establishing the first bacteriological laboratory in this country, and from studies in this laboratory arose the brilliant and beneficent results in the treatment of compound fractures which I have quoted. If one laboratory can give such beneficent results in one single surgical accident, what will not many do, each vieing with all the rest in investigating different important surgical and medical questions as yet unsolved? Could wealthy private citizens erect more useful monu-

[1] Carrel's extraordinary success in transplanting tissues even after being for days in "cold storage," his successful transplantations of the entire kidney and an entire leg in animals, are among the latest achievements of surgery. (1914.)

ments of enduring fame? In Europe the government establishes and supports such laboratories. In America we must look to private munificence, and never yet has humanity made such an appeal to my countrymen in vain.

VIVISECTION AND BRAIN-SURGERY[1]

To "Harper's Magazine" for October, 1889, I contributed a paper in which I demonstrated the fact, and to some extent the causes, of the recent marvelous progress of surgery. In this, as in an earlier publication, I attributed it to a large extent to vivisection. Both publicly and privately my statements have been called in question.

The seven years which have elapsed since my first publication on this subject have demonstrated, far more than I even hoped or expected, the truth of what I then stated, and it would seem right that some of these demonstrated facts should be laid before the public. Moreover, the recent revival of the discussion of the subject before the Church Congress at Folkestone, England,[2] and at the recent meeting of the Humane Society in Philadelphia in October, 1892, makes it especially timely.

I shall omit many topics which would be suitable, such as the wonderful results of Pasteur's treatment of hydrophobia, the discoveries of bacteriology, the wholly new class of remedies which medicine owes to vivisection, such as the antidotes to lockjaw and several other diseases, derived from the blood of animals inoculated with the virus of these diseases — remedies to which we already owe astonishing cures. In the present paper I propose to limit myself to brain-surgery alone, and to give a glimpse of what has been done up to the present time. I shall show especially that without the exact knowledge of the functions of the brain, derived almost wholly from experimentation upon animals, it would be simply impossible to do what

[1] Reprinted by the kind permission of Harper & Brothers from *Harper's Magazine* for June, 1893.

[2] *Church Times*, October 14, 1892, p. 1021.

has been accomplished. I shall not restrict myself to general assertions which may easily be denied, but I shall relate actual cases, with their definite results, and the authority for each case.

In order to understand modern progress in cerebral surgery it is necessary first to understand what has been achieved by experimentation upon the brain. When I was a student of medicine, thirty years ago, the brain was regarded as a single organ, and its various functions were not thought to have any especial localized centers of action.[1] When the brain acted it was thought that the whole of it acted, just as the liver or the kidney acts, as a whole. Now we know that instead of the brain being a unit, it is really a very complex organ. Just as in the abdomen, besides the other organs in its interior, we have the stomach, the liver, the pancreas, and the bowel, each of which has its part in digestion, so correspondingly in the brain, besides the portions concerned in sight, smell, thought, etc., we have four adjacent portions which are concerned in motion. One produces motion of the face; another, motion of the arm; a third, motion of the leg; and the fourth, motion of the trunk.

How, it may be asked, have these facts been determined? Has it not been by observing the effects of injuries and diseases in man? To a small extent, yes. But very, very rarely does disease or injury involve only one of these very limited regions of the brain; and the moment two or more of them are involved our inferences become confused and misleading. As a matter of fact which cannot be gainsaid, nine tenths of our knowledge has been derived from exact experiment upon animals, and in this way: A monkey is etherized, a certain area of its brain is exposed, and an electrical current is applied. This stimulation of most

[1] The "bumps" or localized centers of phrenology were always discredited by the medical profession, and experiments upon animals and observation in man have entirely overthrown them.

portions of the brain is followed by no motion in any part of the body. These parts of the brain, therefore, have nothing to do with motion, but are the centers for general sensation (touch), or for certain special senses, as sight, hearing, etc., or for mental processes. But in one definite region of the brain, called the "motor area," the moment the brain is stimulated by the electrical current motion is produced. Moreover, it was soon found that stimulating different parts of this motor area produced motion in different parts of the body, and that this was not haphazard, but that stimulation of one part of it always produced motion in the arm, and in another part always motion in the leg, etc. Thus have been mapped out the various portions of the motor area, as will be presently described in detail.

It is evident that by experiment upon animals the motor area can be more easily and more exactly determined than can those regions which are the seat of the faculties of smell, taste, sight, and hearing, the presence or absence of these senses in animals being difficult to determine with absolute accuracy. Still more is this true of the parts of the brain which have to do with mental processes. Yet disease and injury in man, if they alone could answer the questions what part of the brain has to do with motion, what part with sight, what part with the intellect, ought to have answered them long ago. No better evidence could be given of the superiority of experiment upon animals over observation of accident and disease in man in determining facts of this character than this, that those centers are best and most accurately known which can be determined by vivisection, and that those in which vivisection can aid us but little are still only vaguely located. Thus the motor area is positively and definitely located; the area for sight approximately well; those for hearing, smell, and taste and general sensation (touch) are still uncertain, though guessed at. As to those for mental processes, except perhaps one which will be alluded to later, we are almost

wholly in the dark. Moreover, disease and accident have made their cruel and rude experiments ever since the world began. But as a matter of fact the last fifteen years of experimentation have taught us more than the previous fifteen hundred years of careful observation and of *post-mortem* examination.

Let me now briefly explain this "localization of function" in the brain, and then show its value and certitude by cases which arouse our interest not only by their illustrating the practical applications of science, but by the cheering and humane results in the relief of human suffering and the saving of human life.

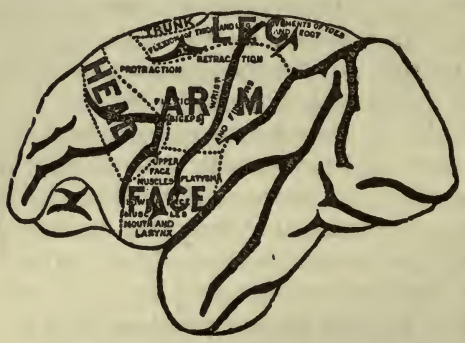


FIG. 1. Side view of the surface of a monkey's brain, showing the location of the various fissures and of the motor centers. (*Horsley and Schäfer.*)

Fig. 1 represents the motor area as ascertained by many experiments such as I have described upon the brains of monkeys. On its surface will be observed certain broad black lines labeled, from in front backward, "Precentral sulcus, Fissure of Rolando, Intraparietal fissure, External parieto-occipital fissure, Fissure of Sylvius, Parallel fissure," and others without names. In the middle, running downward and forward toward the left hand of the figure, notice especially the fissure of Rolando. This and the fissure of Sylvius are the most important fissures of the entire brain. The fissure of Rolando is, so to speak, the "axis" of the motor area of the brain. At its upper end will be observed the center for the leg, with certain minor divisions marked in smaller letters. In its middle lies the arm center;

and it should be remarked that the part where the word "retraction" is is the shoulder center, a little lower down is the elbow center, and where "wrist and fingers" occurs is the hand center. At the lower end of the fissure of Rolando lies the center for the face, and at other points will be observed the centers for the trunk and head. By the word "center" is meant that, for example, if you expose the part of the brain marked "arm," and apply the poles of an electric battery to that portion of the surface of the brain, you will produce muscular movement in the arm. If at the upper end, you will move the shoulder; at the middle, the elbow; lower down, you will move the hand, etc. This diagram shows the fissures and centers as ascertained in the brain of the monkey, but it must be remembered that they have an exact parallel in the human brain. The same fissure of Rolando exists there, the same fissure of Sylvius, the same intraparietal fissure, etc., as is seen in Figs. 3, 6, 8, and the same centers for the arm, leg, trunk, and head. When I state that these exist in the human brain I am not stating what is theoretical, but that which, in common with scores of surgeons, I have verified in many cases in which I have exposed the human brain, applied the battery exactly at the places shown in this diagram of the monkey's brain (with such modifications as would follow the slightly altered relations of the same parts in the human brain as compared with the monkey's), and have obtained in man exactly the same resulting motions as have been thus experimentally determined in the monkey.

Naturally the first question that will occur will be, "This diagram shows the fissures and centers on the brain, but how are you going to tell from the outside of the head, without opening the skull, where they lie?" This has been determined by careful study of the human brain and skull, and their relations to each other. I will give only one illustration, and that by far the most important, namely, how we locate the fissure of Rolando, and therefore practically

the whole motor area. Measure any head in the middle line, from a point between the eyebrows to that bony prominence which any one of my readers can feel at the back of the head just above the border of the hair. These points are called respectively the "glabella" and the "inion." Divide this distance into two equal parts, and thus obtain the mid-point between them. The fissure of Rolando starts half an inch behind this mid-point between the glabella and the inion, and runs downward and forward at an angle of 67°. There have been constructed various simple and other complex apparatuses for the purpose of determining just this angle of 67°, but it was reserved for Mr. Chiene, of Edinburgh, before the Congress of American Physicians and Surgeons in Washington, in September, 1891, to point out the simplest possible method of determining this angle, which any one of my readers can use. If a square of paper be folded diagonally, it is obvious that the right angle of 90° at two of the corners is divided into two halves, or two angles of 45° each. If the paper be then again folded so as to divide one of these angles of 45° into two angles of 22.5° each, it is evident that one angle of 45° and another of 22.5° make an angle of 67.5°, which varies only half a degree from that of the fissure of Rolando. (Fig. 2.) If the middle line of the head be marked with an aniline pencil on the shaven scalp, if its mid-point be then fixed, and if the strip of paper just described be so placed that its edge indicating the angle of 67.5° runs downward and forward from a point half an inch back of the mid-point, the edge will correspond to the line of the fissure of Rolando, and can be marked by the aniline pencil on the scalp. If this line be measured for a distance of $3\frac{3}{8}$ inches from the middle line of the head, the length of the fissure of Rolando is also shown.

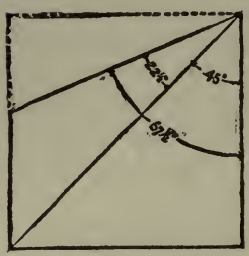


FIG. 2. Professor Chiene's method of finding the angle of the fissure of Rolando.

It is not necessary for me to go further into details. I propose now, after having thus explained the "localization of function" in the brain, and the means of locating the motor area from the exterior, to show not only that, as a matter of fact, it has been verified in actual surgical experience, but also that it is so accurate that from the exterior of the head, without any scar or other evidence of injury (or even in the presence of an otherwise misleading scar), without any fracture of the skull, without any lump, prominence, or other means to guide us, cerebral localization is a reality, and as reliable as the needle of the compass itself to guide us exactly to the correct spot, so that we can open the head and expose the brain with an accuracy which is truly marvelous. If the last fifteen years of experimentation have done so much, what may we not expect in the next fifteen? Does not humanity as well as science protest against any hindrance to the further prosecution of work which has accomplished such results? Is this the work of "inhuman devils," as Canon Wilberforce has been pleased to term those engaged in it, or is it the work of humane men of science anxious to mitigate human suffering and prolong human life?

Now let us see what results practical surgery has given us by the application of the doctrines of cerebral localization of function to special cases, otherwise beyond our power exactly to diagnosticate and to relieve. In each case I give the published authority, or, if the case has not yet been published, the records are accessible in the hospitals named. The cases are not of the time of John Hunter or of Sir Charles Bell, but of the last few years, and can be investigated and verified now.

The first case shows that it is possible not only to diagnosticate in general the fact that an abscess exists in the brain, but to locate it exactly, and to open it with the same precision as in opening an abscess on the hand. What is more to the point, in about one half of such cases we can

now cure the patients who, before vivisection had taught us modern cerebral localization, would all have gone to their graves.

Case I. *Abscess in the brain.* In the "British Medical Journal" of April 21, 1888, Mr. Damer Harrisson records the following case. A boy aged fifteen had received a blow on the *right* side of his head from a pair of tongs eight days before his admission to the hospital. Three days after the accident a convulsion suddenly set in, involving the *right* side of the body, beginning in the arm and spreading to the leg and face, and followed rapidly in four days by eight other convulsions and paralysis of the entire right side of the body. Most of my readers would unhesitatingly attribute the convulsions and the paralysis to this blow from the tongs. But it must be remembered that the right side of the brain supplies the *left* side of the body, and *vice versa.* Hence Mr. Harrisson suspected that the paralysis of the right side of the body indicated trouble in the *left* half of the brain. Examining his head, he found on the left side a small scar at the junction of the arm and leg centers. Inquiry elicited the fact that, *ten years before,* he had received a severe blow there, which, however, had not been followed by any serious symptoms. Could this old injury, after so long a time as ten years, possibly be the cause of his present serious trouble? Further inquiry brought out the fact that for about a year before his admission the boy had had repeated twitching of his right arm. So convinced was Mr. Harrisson that modern cerebral localization was right that he opened the boy's skull, not where most people would suppose would be natural, namely, on the right side of the head, where he had received the blow from the pair of tongs eight days before, but on the left side, at the site of the blow ten years before, and at a definite point, namely, over the fissure of Rolando, at the place corresponding to the motor center for the arm as established by experiments on animals. Although the first injury was received so long

before, yet the paralysis showed that it was the left side of the brain that was involved, and the twitching of the arm showed that this was the particular part of the left side of the brain where the injury probably existed. Mr. Harrisson punctured what seemed on the surface to be a normal brain, and opened an abscess, and this boy, otherwise absolutely doomed to death, made an uninterrupted recovery. This is only one instance out of probably more than one hundred and fifty cases of abscess in the brain which have been reported within the last seven or eight years which have been diagnosticated with the same accuracy and by the same means.

Case II. In the "British Medical Journal" for August 11, 1888, Dr. (later Sir William) Macewen, of Glasgow, relates the case of a patient who, among other symptoms of abscess of the brain, had partial paralysis of the right side of the face and right arm, and paralysis of the nerve supplying the left eyeball. For reasons stated in the paper he concluded, with great acuteness of reasoning, that the abscess could not be *in* the motor area for the face and arm on the left side of the brain, but in the projecting part of the brain just *below* these centers, but producing pressure upon them. (Fig. 3.) He confidently operated at this precise spot, and opened an abscess inside of the brain in the exact position described, and gave exit to *six tablespoonfuls* of pus, when the symptoms vanished, and in three weeks the patient was well!

Fig. 3. Case II. Side view of the human brain. The shaded area shows the location of the abscess producing pressure on the lower part of the motor area. (See Fig. 1.)

Brain tumors. Nothing could be easier than to locate a tumor of the brain which showed itself externally. In a case in which the tumor is as large as that shown in Fig. 4

(which is the natural size of a tumor removed from a man who is still living, five years after the operation)[1] it might be thought easy to locate it, though, as a matter of fact, it is very difficult, owing to the large area of brain involved. But when I say that the existence of a tumor about the size of the end of the forefinger can be diagnosticated, and

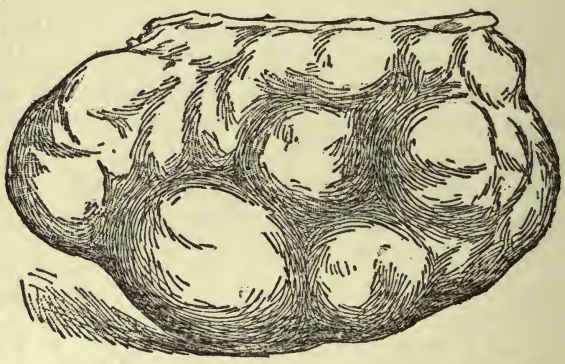


FIG. 4. Natural size of a tumor removed from the brain. The patient is living after twenty-seven years. (1914.)

that before touching the head it should be said (and I was present when the statement was made), that it was a small tumor, that it did not lie on the surface of the brain, but a little underneath it, and that it lay partly under the center for the face and partly under that for the arm in the left side of the brain, and that the man was operated on, and the tumor found exactly where it was believed to be, with perfect recovery of the patient, it is something which ten years ago would have been deemed the art of a magician rather than the cold precision of science.

CASE III. In the "American Journal of the Medical Sciences" for July, 1888, this case is detailed by Drs. Seguin and Weir, as follows. A gentleman thirty-nine years of age had been perfectly healthy until August, 1882, when

[1] He is still alive in 1914, twenty-seven years after the operation.

he had malarial fever, accompanied with a good deal of pain. One day, as he rose to go to the window, his wife noticed a spasm of the right cheek and neck, which did not involve the arm, nor was consciousness lost. In 1886, two or three similar attacks having occurred in the interval, he fell, unconscious, and bit his tongue. These attacks were all accompanied with twitching of the right arm and hand and right side of the face. His memory became impaired and his speech thick. No injury had ever been received on his head, nor was anything abnormal observed even when his head was shaved. Gradually his right hand and arm became weak, and, as a result, his handwriting became bad. This weakness of the right arm slowly increased, and along with it a weakness of the right leg, and, as a consequence of the increasing paralysis of his face, drooling at the right side of the mouth set in.

Dr. Weir examined him at Dr. Seguin's request, and both of them reached a diagnosis, chiefly based upon the facts already given, that the man had a small tumor situated as above described, and on November 17, 1887, the skull was opened at the junction of the arm and face centers. This operation I had the pleasure of witnessing personally. Nothing abnormal was seen on the surface of the brain. Yet so confident was Dr. Weir of the correctness of the diagnosis that he boldly cut into the brain substance, and from its interior removed a tumor of the size indicated by means of a small surgical spoon. The

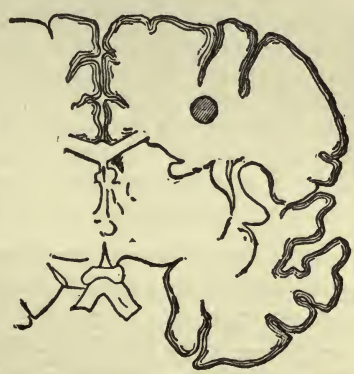


FIG. 5. CASE III. A cross-section of the brain (only a part of the left side is shown.) The round shaded spot represents the brain tumor. (Weir and Seguin.)

man made a perfect recovery. When examined microscopically, the tumor was found to be of a malignant character. It returned in about four years, and finally destroyed his life. Fig. 5 shows the tumor represented as a little ball in the substance of the brain.

In one sense, as a surgical feat, the removal of a tumor as large as that shown in Fig. 4 is a much more difficult and extraordinary operation (and one nearly twice as large, weighing over half a pound, has lately been successfully removed by Bramann!); but as a matter of diagnosis and of surgical skill, locating and removing so small a tumor from the brain so successfully, and without the slightest indication on the exterior to guide one, is a much more brilliant and remarkable operation.

In an address which I published in 1885[1] I alluded to the first and then the only case known of removal of a brain tumor, and I said: —

> By these experiments and operations a wide door is opened to surgery in the treatment of diseases within the skull, diseases heretofore so obscure and uncertain that we have hardly dared to attack them. The question is not whether death or recovery followed in this particular case. The great, the startling, the encouraging fact is that with this experience we can now, with well-nigh absolute certainty, diagnosticate the existence of, and with the greatest accuracy locate, such diseases, and therefore reach them by operation, and treat them successfully.

That my prophecy has been verified, let me quote the statistics gathered by Dr. Knapp, of Boston, in 1891. He collected forty-six cases of operations for tumors of the brain, operated on in the last six years, of which thirty recovered (!), fifteen died, and the result was unknown in one. It must be remembered that these thirty which recovered would every one of them have died had not vivisection given us the means of accurately locating the disease. That we have not yet reached the accuracy which is

[1] "Our Recent Debts to Vivisection," *ante*, p. 13.

to be desired is shown by the fact that in fifteen other cases no tumor was found at the point of operation, and of these thirteen died. Most of these tumors lay not in the motor region of the brain, but in other parts of it, in which our means of diagnosis are as yet very imperfect for the very reason that vivisection has thrown but little light on the function of these regions. There were also four cases of tumors which were found, but were so large as to be irremovable, and of these three died. To these statistics I can add three other cases. In one of these the tumor was not rightly located (it was not in the motor region), and therefore was not found at the operation, and the patient died. In the other two cases the tumor was found, but was irremovable. One patient died, and the other recovered from the operation, but died from the disease four months afterwards. He had, however, been relieved from the atrocious headaches which rendered life a burden, and his delusional insanity had almost wholly disappeared — results which fully justified the operation by the comfort of his few remaining days.[1]

Case IV. *Hemorrhage inside the skull.* Let me next give a case of a different character, but equally accurate and astonishing. An artery about as large as the lead in an ordinary lead-pencil runs in the membranes of the brain on the inside of the skull, in the region called "the temple," and grooves the bones quite deeply. In some cases in which a heavy blow is received on the surface of the skull, without fracture, or it may be even without leaving any mark whatever on the skull, this artery is ruptured, and a large clot is poured out on the surface of the brain. Formerly it was not only almost impossible to make a diagnosis of such an injury, but, even if the rupture of the artery was suspected,

[1] Another remarkable case, in which a growth of the under surface of the bone pressing on the arm center was exactly located and successfully removed, is related by Dr. A. B. Shaw, of St. Louis. (*American Journal of the Medical Sciences*, December, 1892, p. 691.)

before antiseptic surgery (itself the child of vivisection) arose, such patients were only treated with a little opium, rest, and regulated diet. Most of them died, but occasionally one got well. Of 147 cases collected by Wiesmann which were *not* operated on, 131, or over 89 per cent, died. The symptoms of such an injury are fairly clear, but, until the doctrines of cerebral localization were accepted, were often misleading. The patient is stunned by the blow, but usually recovers consciousness, only to relapse again into unconsciousness when the amount of blood poured out is sufficient to compress the brain, this compression of the brain producing also paralysis. Generally the artery on the same side of the head as the blow is ruptured, and the paralysis will be on the opposite side of the body. But sometimes, instead of the artery being ruptured on the same side as the blow, it will be ruptured on the opposite side; or, again, if the blow be in the middle line, as in a case recently under my care, it may be difficult to tell which side has been involved. Moreover, as the artery splits into two branches, one of which runs in the direction of the motor region and the other back of it, it may be difficult to know where to open the skull in order to reach it. Now it is very evident that if we make an incision into the forearm to reach an abscess or a tumor, and it is found that the trouble lies one or two inches further up or down, the incision can be easily prolonged in the right direction, and will heal readily. But in the skull our diagnosis must be correctly located within a very small limit of error, for it is evident that we cannot enlarge the opening in the bone at will to almost any extent, as we can in the flesh. Wiesmann has also collected 110 cases which *were* thus operated on, of whom 36 died, or only 33 per cent![1] What a contrast to the 89 per cent of deaths when no operation was performed! In the majority of these 36 who died the clot was not found,

[1] See "Midshipman Aiken and Vivisection," *post*, p. 146, whose life was saved by operation.

and was therefore not removed, because in the earlier days we lacked the boldness and therefore the exactness of modern times.

Case V. Let me now give the case furnished me by Dr. Dench, by permission of Dr. Bull, of New York.[1] A young man had been shot in the head, the ball entering above the ear, two and a half inches to the left of the middle line of the head. When first seen his right arm was paralyzed, and shortly afterward the paralysis had extended to the right leg and right face. A diagnosis was made of hemorrhage from one of the arteries of the brain, by reason of the fact that the paralysis had extended so rapidly from the arm center to the leg and face centers, for no other cause excepting hemorrhage could be so rapidly progressive. The wound was exposed, and a considerable clot gushed out, when motion immediately returned in the leg. The bone was then trephined, not at the bullet opening, but a quarter of an inch below and in front of the wound, when this bleeding meningeal artery was exposed and tied. It was found that a large branch of an artery in the brain itself had also been severed. This was tied, and in two months the man was well, no fever following, and no "matter" having formed. He could speak perfectly well, and could use his arm, but not his hand. The ball was never found.

Case VI. It may be objected that here there was a wound to point out exactly the situation of the injury. Let me therefore give a somewhat similar case in which no such guide existed: M. Michaux[2] reports a case of trephining, followed by cure, for a case of meningeal hemorrhage, probably of spontaneous origin. A man was brought to the hospital in a state of complete apoplexy, with paralysis of the left face and right arm. There was no sign of fracture or other injury. During the next few days the paralysis

[1] Buck's *Reference Handbook of the Medical Sciences*, vol. VIII, p. 227.

[2] *Medical News*, May 2, 1891, p. 504, from *Revue de Chirurgie*, 1891, vol. XI, p. 376.

extended to the right leg. Epileptic convulsions set in, at first limited to the paralyzed regions, then becoming general. Occurring at intervals in the beginning, they became continuous at the end of three or four days. The patient was addicted to absinthe, and his head had troubled him for several months. The trephine was applied over the fissure of Rolando on the left side, over the "motor area" for the arm and leg, and an opening six centimeters long was made, through which the membranes of the brain were incised. This was followed immediately by the escape of four tablespoonfuls of large blackish clots After the operation the patient improved rapidly, and in a month most of the symptoms had disappeared.

Drs. Bremer and Carson, of St. Louis,[1] and Drs. Homans and Walton, of Boston,[2] have published cases in which, also without external signs, such clots have been accurately located and removed with success. In the latter case there was evidence of an injury, but the clot was on the opposite side of the head.

Mental disorders. I shall now add a case involving the centers for mental processes, in the establishment of which vivisection has done but little, for reasons already explained, but the case is one of great interest and value.

If the reader will look at Fig. 1, find the fissure of Sylvius and follow it to its upper end, he will see that this end terminates in a Λ-shaped convolution between the intraparietal and the external parieto-occipital fissures. In this portion of the brain have been located certain mental processes, including the ability to recognize objects and their uses. The location of this convolution of the brain can be made with almost the same accuracy as that of the fissure of Rolando.

Case VII. The following case of Macewen of Glasgow[3]

[1] *American Journal of the Medical Sciences*, February, 1892, p. 134.
[2] *Boston Medical and Surgical Journal*, February 12, 1891.
[3] *British Medical Journal*, August 11, 1888, p. 306.

will illustrate the accuracy of this localization. A year before Macewen saw him the patient had received an injury which had resulted in melancholia. Though formerly a happy husband and father, he now repeatedly contemplated the murder of his wife and children. There were no phenomena connected with motion in any part of the body by which the injury could be located; but it was discovered by that careful, close investigation for which this surgeon is so well known that, immediately after the accident, for two weeks he had suffered from what is called "psychical blindness," or "mind blindness"; that is to say, his physical sight was not at all affected, but his mind was not able to interpret what he saw. I presume he was a stanch Scotch Presbyterian. He knew that, as was customary, his New Testament was lying by his side, but when he looked at it he was utterly unable to recognize it. While, however, his mental sight was thus affected, his sense of touch was perfect, and when he passed his hand over the smooth leather cover of his well-known book and felt the deep-indented letters on the back he recognized it as his familiar friend; but when he opened it, the printed words were unknown symbols to him. This gave to Macewen the key to the injury. He located on the outside of the skull this A-shaped convolution (Fig. 6, shaded area), known as the "angular gyrus," and found, on removing a button of bone, that a portion of the inner layer of the bone had become detached and was pressing on the brain, one corner of it being imbedded in the brain substance. After removing the splinter, the button of bone was replaced in its proper position. The man got well, and, although still excitable, lost entirely his homicidal tendencies and returned to work.

FIG. 6. CASE VII. Side view of the human brain. The shaded area shows where the bone pressed on the A-shaped angular gyrus. (Macewen.)

Epilepsy. If I were to gather together the operations which have been done for epilepsy since we have been able to locate the centers, especially for motion, I should perhaps have to record one hundred and fifty or more. The great majority of these patients have recovered from the operation, or, in surgical parlance, have made an "operative recovery," but in a very large proportion the disease has returned, generally, however, with a lessened intensity. In a small proportion recovery has taken place from the disease itself. But it is evident that as cerebral surgery covers practically only the last eight or ten years, it is much too early to formulate definitely a statement of what the results may be when a longer time has elapsed.

Case VIII. In the "American Journal of the Medical Sciences" for December, 1891, Dr. Charles K. Mills, of Philadelphia, has reported the case of a young lady twenty-seven years of age, who suffered for some time from numbness and a sense of weight in the left arm, hand, and foot. After about five years these attacks developed into distinct epileptic fits, and had become extremely frequent at the time when Dr. Mills first saw her, in November, 1890. The attacks occurred both in the daytime and at night, and were as frequent as ten to fifteen in the twenty-four hours. Dr. Mills himself often saw them. The left arm was first raised, the motion beginning in the shoulder, and including also the elbow. The attack quickly extended over the entire body. On the outside of the head, after it had been shaved, absolutely nothing was found which could be a guide to the site of the trouble. The diagnosis was some source of irritation, the character of which was unknown, but which was located on or in the center for the left shoulder. Accordingly the fissure of Rolando was mapped out on the shaven head, and a button of bone an inch and a half in diameter was removed, the center of which was an inch and three-quarters to the right of the middle line. Fig. 7 shows the button of bone, the inner surface being upper-

most. The bone was very thick, from five to seven sixteenths of an inch, and was also very dense. As soon as the bone was removed, a small tumor resembling in shape a minute bunch of grapes was found, the apex of the tumor being within *one sixteenth of an inch of the point where it was believed to exist.* By its pressure it had produced several pits on the inner surface of the bone, and these holes, as well as the groove for a large blood-vessel which supplied the tumor with blood, are well shown in the middle of the button.

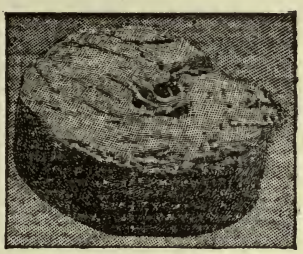


FIG. 7. The button of bone removed in Case VIII. The pits in the bone were produced by the tumor. They were almost precisely in the center of the button, and thus show how exactly the tumor was located. (Mills.)

The tumor, with the membrane of the brain to which it was attached, was removed, and the battery was then applied to the brain immediately underneath it. Fig. 8 shows the fissure of Rolando as a line running downward and forward across the circle. The circle represents the button of bone removed, and the numbers 1 to 4 represent the points at which the poles of the battery were applied to the brain. On stimulating the brain at the point marked 1, and

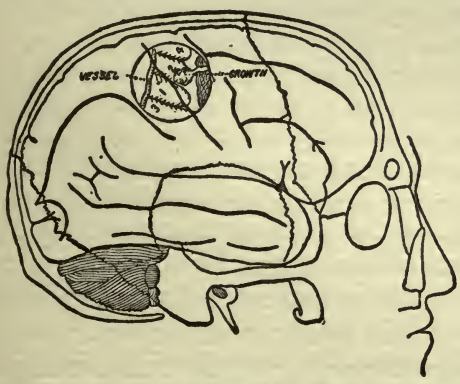


FIG. 8. The brain in Case VIII. The circle shows where the button of bone was removed, and the growth found almost exactly at the center of the button. (Mills.)

again at point 2, movements of the arm at the shoulder and elbow were reproduced; precisely the movements of her attacks. This point was the portion of the brain pressed upon by the tumor. Along with the movements of the shoulder at point 1 the elbow was involved, and at point 2 it was found that the hip and knee were both flexed, and the entire leg carried away from its fellow, the toes and foot being extended. It was very evident, then, that point 1 corresponded to the shoulder and elbow centers, and point 2 corresponded to the upper edge of the shoulder center and also to the edge of the leg center. Excitation at point 3 was followed by more decided movements of the lower arm, and at point 4 the leg alone moved, the shoulder not being involved.

Could any better illustration be found of the accuracy of localization? The leg center here, when compared with the leg center in Fig. 1 of the monkey's brain, is found exactly where it ought to be, the arm center directly below it, with the shoulder, elbow, wrist, and hand movements precisely in the same relative positions as in the monkey's brain. Unfortunately the lady has not been cured. But the fits have been greatly moderated, so that when the case was reported, nearly a year after the operation, she had usually only about three attacks in the twenty-four hours instead of ten or fifteen, and the attacks had never attained the same severity as before the operation. Moreover, after the operation, in about half the attacks she did not lose consciousness, and so was far less exposed to the danger of falling the downstairs, into fire, and other similar perils to which epilepsy with unconsciousness exposes a patient.

Case IX. Another case, which is fortunately more favorable in its result, is published in the "Medical News" of April 12, 1890. A little boy, six and a half years old, at the age of fourteen months fell about ten or twelve feet from a haymow upon a plank flooring. He was unconscious for some time. No decisive evidence of injury could be found

either on his head or other parts of his body, but from his prolonged unconsciousness it was presumed that he had struck his head. Soon after this accident his disposition changed materially for the worse. He became irritable, obstinate, and ill-tempered, and very frequently kicked, bit, and scratched, and offered other violence to his playmates. His room had to be padded, his clothes had to be sewed on him every morning, and he would kill any small animals, such as cats or chickens, that came in his way. When two and a half years old his first epileptic fit occurred. He had from three to six attacks a day, with some intervals of comparative freedom. His father, an intelligent clergyman, estimated that in the four years since his epilepsy began he had had over five thousand fits! Of these about eighty per cent began in the right hand. The attacks were observed with great care in the Jefferson Medical College Hospital by a special nurse, and the statement of his father that they usually began in the right hand was verified. When the attacks began the child had a vocabulary of about forty words, but gradually these were reduced, word by word, until his speech consisted only of three words and a little jargon, the words being "papa," "mamma," and, characteristically "no," rather than "yes." Examination of the head revealed nothing that could locate any injury; but as the attacks began so constantly in the right hand, it was resolved to remove the center for this part of the body, in the hope that if the fits were prevented at their initial spot they would not begin elsewhere. The fissure of Rolando was first located, then the position of the hand center was marked, and a disk of bone an inch and a half in diameter was removed. The membranes of the brain were then opened, and the brain itself exposed. Nothing abnormal was perceptible either by eye or by touch. The battery was applied to the portion of the brain exposed, producing movements of the hand, showing that the center had been correctly mapped from the outside of the skull. Excitation

of the brain further upward produced elbow movements (elbow center). These centers were therefore exactly where they ought to lie, as shown in the monkey's brain (Fig. 1). The portion of the brain that moved the hand was then removed, and when the battery was applied to the parts around it, it was found that all the center for the hand and wrist had been removed.

The boy made a speedy recovery from the operation. Three years have now elapsed since the operation. Most of the time he has been and still is in Misses Bancroft and Cox's School for Feeble-minded Children, at Haddonfield, New Jersey. He has had there very painstaking care, and to this is to be attributed very much of his mental improvement. During the last six months of 1892 he has had only one attack for about every sixty before the operation. This improvement can be attributed only to the good effects of the operation.

Case X. The last case to which I shall refer has not been published, but can be found in the records of the Orthopedic Hospital and Infirmary for Nervous Diseases in Philadelphia, Record Book S. 9, p. 123. A young girl of about twenty-one was admitted to the infirmary in October, 1891. She said that her attacks of epilepsy, from which she had suffered for two years and a half, always began in the right thumb. This fact having been verified, it was decided to remove the center for the thumb, for the same reason as in the last case, i.e., to stop the very beginning of the fit. It was especially desired to remove only the center for the thumb, and not that for the hand, in order not to interfere more than was necessary with the usefulness of her hand, upon which she depended for her support, as she was a mill-girl. This was an unusual and minute attempt at localization, and a very severe test of the accuracy of the mapping of the brain by vivisection. On October 6, 1891, the fissure of Rolando was first located, and a disk of bone an inch and a half in diameter was removed, the center of it being two

and five eighths inches to the left of the middle line. Both the bone and the brain, when exposed, seemed to be normal. The fissure of Rolando was seen crossing the middle of the opening, downward and forward (Fig 9). By the battery the brain was stimulated at certain definite points until the thumb center was recognized, and also the face center, which lay somewhat below it, and the wrist center, which lay — as it ought by experiments on the monkey's brain — a little above it. Each of these centers was recognized by the movement of the part supplied by it (thumb, face, wrist) when the center was touched by the poles of the battery. Stimulation of the thumb center produced a typical epileptic fit, such as she had suffered from since her admission, beginning in the thumb, as she had asserted. The portion of brain corresponding to the thumb center, a piece about half an inch in diameter, was removed, and by the battery it was determined that the portion removed was the whole of the thumb center. She recovered promptly and without disturbance from the operation.

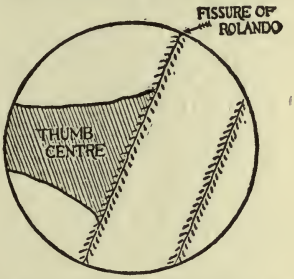


FIG. 9. CASE X. The circle represents the opening in the skull disclosing the thumb center almost at its middle. The shaded area represents the part of the brain which was removed.

It was necessary in this case to be unusually accurate, and not to remove any portion of the brain other than the center for the thumb, and for three reasons: First, if too much were removed upward and backward, the wrist and fingers would be paralyzed; second, if too much were removed forward, the muscles of the face would be involved; third, a little further down lies the center for speech, and had this part of the brain been injured, this important faculty would have been destroyed, thus producing serious and unnecessary trouble.

Note now the accuracy of experimental cerebral localization. As soon as the patient had recovered from the ether and was in a suitable condition, her ability to move the face and hand was tested. All the muscles of the face were entirely intact, and could be moved with absolute ease. Her speech also was unaffected. She had absolute and perfect control of all the muscles of the shoulder, elbow, wrist, and hand, *with the single exception of the muscles of the thumb, every one of which was paralyzed.* In order to understand how curious this paralysis is in relation to the thumb center in the brain, the reader must observe that only a small piece of the brain, half an inch square, was removed, whereas the muscles of the thumb lie as follows: some of them in the ball of the thumb on the hand, one between the thumb and forefinger, one on the front of the forearm reaching almost to the elbow (the great flexor of the last joint of the thumb), and three of them on the back of the forearm, extending half-way from the wrist to the elbow; and yet the removal of so small a portion of the brain paralyzed these muscles of both widely different situation and widely differing functions (flexion, extension, abduction, adduction, and circumduction).

By June, 1892, she had entirely recovered the use and strength of her thumb, as shown by the dynamometer, both sides then registering the same number of degrees.

This history illustrates one of the most curious problems of cerebral surgery. The removal of any portion of the motor region of the brain is, of course, followed by palsy of the part of the body supplied by that brain center; but though I have frequently removed portions of the brain, I have never yet seen this paralysis permanent. I have seen a right hand wholly paralyzed after such an operation, and in three months it had regained its strength and dexterity sufficiently to enable its owner to play baseball. But while this is true of the careful removal of small parts of the brain by operation, the widespread injuries which result

from accident are not seldom followed by extensive palsies which remain throughout life. In the case just related not only has strength returned equally, but such delicate movements as are involved in the use of a needle have been preserved, or rather restored. Usually, however, weakness, to a greater or less extent, will remain in the part of the body controlled by the portion of brain removed. Whether there is actual reproduction of brain tissue or not is as yet uncertain, because after such operations there have been almost no deaths at a period sufficiently remote to enable us by *post-mortem* examination to determine whether such a reproduction has occurred or not. It is possible that the similar center on the opposite side of the head is capable of doing double duty; for although normally the right side of the brain controls and moves the left side of the body, and *vice versa*, yet apparently there is a latent power which when necessary is called into play, and enables the right side of the brain to innervate and control the same side of the body as well as the opposite side, just as, for instance, the left hand, which is unused to writing, can acquire the faculty of writing if the right hand is lost.

There has also been performed a very remarkable operation on animals which may hereafter produce important results. Several experimenters have opened the heads of two dogs (both under an anesthetic, and both as carefully and as tenderly cared for as any human being could be, the operations being attended with but little pain,[1] as they were done with the most careful antiseptic precautions), have taken a bit of the brain from the head of each dog and transferred it to that of the other dog. The pieces so transferred have grown in place, and have caused at least no mischief. Whether it will ever be possible to transfer brain

[1] Most operations on the brain are followed by very little pain, and sometimes it may truthfully be said by none. It is not an uncommon result for the patient to take no medicine, or at most a single small dose of an anodyne on the first day, be out of bed in three to five days, and entirely well in a week or ten days.

tissue from the lower animals to man, and whether if so transferred it will properly perform its function, are problems as yet unsolved. It would be, I think, unwise to test its effects in man except as applied only to the motor regions at first, for we have every reason to believe that the motor cells in an animal's brain subserve precisely the same function as the motor cells in the human brain. Moreover, nothing of this kind would ever be done excepting perhaps in case of an accident where a considerable portion of the human brain was destroyed, when possibly this loss could be made good from an animal's brain. It is unnecessary, however, to discuss this question at present, for all the facts in the case, the needful precautions to be taken, and all the possible results, must first be determined in much greater detail and by much larger experimentation on animals than has yet been done before it will ever be considered in man. But it is not at all impossible that in this way we may see hereafter one of the most brilliant achievements of modern cerebral surgery.[1]

But we must return again to our last patient, for her subsequent history as to her epilepsy is quite as interesting as, and to her no doubt even more important than, the condition of her thumb. On December 17, 1891, seven weeks after the operation, she had one slight attack. January 13 and 30, 1892, there were two; then none until March 12; a very slight one came on May 19; and the last to date were two on July 8 (slight) and 10, making in all seven attacks in eight months. Thus the intervals were growing longer, and the attacks as a rule less severe, while before the operation the attacks were growing more severe and far more frequent, for when she entered the infirmary they were tending to become daily.[2]

[1] So far (1914) no progress has been made in this direction. The value of the experimental research in animals in preventing such dangerous attempts in human beings is evident.

[2] Since this was written her attacks have become somewhat more frequent, but are still far less frequent and severe than before the operation.

The anti-vivisectionists constantly parade the few physicians who are in accord with their views, and by frequent reappearances make an apparent army upon the stage. As a matter of fact, Mr. Lawson Tait is the only one who has an international reputation; the rest are but little known. Even Mr. Tait recently changed his views, and in a speech in favor of the objects of the British Institute of Preventive Medicine, which are largely attained through vivisection, has declared: "bacteriological experiments on animals have proved of great value." What the real opinion of the medical profession of Great Britain is as to the value of vivisection is seen by the following resolution, which was passed in August, 1892, at the Nottingham meeting of the British Medical Association, and passed unanimously. The weight of such an authority can best be measured when I state that it is the largest and most important association of physicians in the world, and numbers over fifteen thousand members, including most of the distinguished men of the profession in Great Britain.

Resolved, That this general meeting of the British Medical Association records its opinion that the results of experiments on living animals have been of inestimable service to man and to the lower animals, and that the continuance and extension of such investigations is essential to the progress of knowledge, the relief of suffering, and the saving of life.

I have thought it worth while not to content myself with broad assertions that experimentation on animals has enabled us to locate with absolute accuracy the various motor functions and to some extent the other functions of the brain; but to any doubting Thomas I would simply say, See any brain operation of this character, and you cannot fail to be convinced of its humanity and propriety.

THE PROGRESS OF SURGERY AS INFLUENCED BY VIVISECTION[1]

I HAVE been asked by the editor of the Philadelphia "Record" to write a brief résumé of the influence of vivisection on the progress of modern surgery. I shall do so as briefly as I possibly can, stating only facts which are generally well known to surgeons, but of which the general public of necessity must be ignorant to a great extent. Most of the facts below stated are known to me personally, as they have occurred during my professional lifetime; and I can, therefore, vouch for their accuracy.

If a physiologist were asked to contribute a similar paper, he would be able to tell a similar story as to the revelations of the functions of various organs in the human economy obtained through vivisection; if a professor of pharmacology (i.e., the action of drugs upon the living body) were to write a similar paper, he would be able to show an equal debt owing to animal experimentation, first, in giving us an exact knowledge of the action of drugs, and, secondly, in the introduction of a large number of new drugs. In this way cocain was introduced into medicine and the proper use of such a powerful drug as digitalis was shown.

If a medical man were to write a similar chapter, he would scarcely know where to begin. The whole life history, for example, of the trichina has been studied in animals and the results applied to man, so that if every one would heed the warning, no one need die from the trichina worm in pork. This has had also an enormous commercial value, since all our hog products are exported on condition that the trichina be excluded by microscopical examina-

[1] Reprinted by permission from the Philadelphia *Record* of September 14 and 21, 1901.

tion. In diphtheria the percentage of deaths has been reduced in Baltimore from about seventy per cent to about five per cent. The saving of human life in a single year in New York has been 1500. All this is due to the antitoxin of diphtheria, which has been evolved solely as a result of animal experimentation. . . .

On the border line between medicine and surgery is the new science of bacteriology. In surgery this has shown the cause of inflammation, of erysipelas, of tetanus or lockjaw, of glanders, of tuberculosis (not only of the lungs, but of the brain, the bones, the joints, the bowels, etc.) and of many other disorders.

Let me give one illustration of the method by which the cause of one disease — tuberculosis — was proved. Similar methods are employed in tracing the causes of others. In a case of consumption of the lungs the expectoration is examined by the microscope after applying a staining material. Without staining, the tubercle bacilli are so translucent (like little rods of jelly) that we can scarcely see them. Having found this peculiar germ in the expectoration, some of the material is injected under the skin of a guinea pig. After a certain time the animal either dies or is killed, and a *post-mortem* examination is made. If there are found in the body of the guinea pig little nodules,— i.e., tubercles (little tubers),— these are examined by the same method, and the same germs will be discovered and can be obtained in a pure culture. But the circle of proof is not yet complete. A small portion of this pure culture of the germs obtained from the inoculated guinea pig is again injected into another animal, and if the second animal suffer from a similar disease and the same germ be found again, the conclusion is irresistible that the cause of the tuberculosis is the peculiar germ always found in such cases.[1]

I well remember the incredulity with which I first read

[1] Yet the antivivisectionists deny *in toto* this and all other findings of bacteriology.

of the origin of lockjaw from the soil, but very soon this incredulity was changed to belief in the face of absolute demonstration after this fashion: It had been well known for years that hostlers, cavalrymen, farmers, and persons who were engaged in any occupation about horses were peculiarly liable to lockjaw. After the discovery of the bacillus of lockjaw in 1884, by Nicolaier, when a case of lockjaw occurred, the ground on which the patient had fallen, or the instrument by which he had been hurt, was examined, and a certain bacillus was found in or on it. This was inoculated into animals, and was found to produce the same disorder; and the same bacillus was recovered from the animal's body, and was successfully reinoculated. The circle of proof, therefore, was complete. This explained the popular belief that treading on a rusty nail is a frequent cause of lockjaw; not because it was a nail or old or rusty, but because the germ of lockjaw was on it and in the ground in which it was lying. No such exact experiments are justifiable on man. The sacrifice of a few rats quickly gave us all the desired information. This has almost totally abolished lockjaw as a result of surgical operations, and enabled us to cure it in many cases even after accidental inoculation. Before 1884 it was both frequent and fatal; now it is almost a surgical curiosity, except after neglected accidents.

The two most important surgical discoveries of the nineteenth century were, (1) anesthesia, especially by ether (in 1846) and by chloroform (in 1847); and (2) antisepsis, by Lord Lister, who began his work soon after the middle of the nineteenth century and had distinctly formulated it about the end of the sixties. His remarkable paper in "The Lancet" of April 3, 1869 (when he was simply Mr. Lister, Professor of Surgery in the University of Glasgow), was one of those papers which marked a new era in surgery. Several years before, he had announced that he believed that inflammation and most of our surgical disorders were

due to germs, and that if we could exclude these germs, we would be able to secure the healing of wounds without inflammation and without the formation of pus (matter); yet it was not until 1881 that Ogston and Rosenbach discovered the germs which produce the terrible results of inflammation, such as erysipelas, hospital gangrene (what irony in the name!) abscesses, blood poisoning and even death.

Hemorrhage

One of the most important contributions by Lister to the progress of surgery was the introduction of antiseptic threads (ligatures) of catgut, with which to tie blood-vessels. One of the earliest Philadelphia surgeons, Philip Syng Physick, tried to get rid of the dangers following silk, which had been used to tie arteries ever since Ambroise Paré introduced it in the sixteenth century as a happy substitute for the horrible hot pitch and hot iron which then were the only means for arresting hemorrhage. Physick sought to use buckskin, on the ground that it was an animal substance and would, therefore, disappear by absorption. Dorsey used catgut. Hartshorne used parchment cut in fine threads, and Bellinger and Eve the tendon of the deer. But none of these surgeons succeeded in giving us harmless ligatures until Lister taught us how to use them. In the paper which I have referred to he showed that the old idea of a ligature was that it was a foreign body which was to be got rid of by its rotting through the walls of the blood-vessel. The result was that in a very large percentage of cases the blood-vessel was not stopped by a clot; secondary hemorrhage took place (usually during the second week after an operation), and many a patient bled to death.

I shall never forget one night in the Satterlee Hospital, of West Philadelphia, about ten days after the battle of Gettysburg, when I was called five times to check just

such secondary hemorrhage from the rotting through of silk ligatures. As a consequence of the introduction of antiseptic ligatures by Lister I do not recall in the last thirty years five cases similar to these five that I then attended in one night. In other words, secondary hemorrhage has almost disappeared from surgical experience.

How did Lister find out the proper method of tying an artery? On December 12, 1867, he tied the great carotid artery in the neck of a horse with a piece of pure *silk* saturated with a strong watery solution of carbolic acid, cutting both ends of the thread short and dressing the wound antiseptically. Healing took place without any inflammation. Thirty-nine days after the operation he investigated the parts by dissection, and found that if the thread had not been applied with the antiseptic precautions, secondary hemorrhage would unquestionably have occurred, and in all probability the animal would have bled to death. On January 29, 1868, he applied this principle in the case of a woman of fifty-one with an enormously dilated sac (an aneurism) in the upper part of the great artery supplying the thigh and leg. She, like the horse, recovered without inflammation, and lived for ten months. On November 30 she suddenly died as the result of a rupture of a similar dilatation of the aorta in the chest. This gave Lister the unusual opportunity of examining in a human body the result of his application of an antiseptic thread to the arteries. The case emphasizes one of the great difficulties in studying such questions on human beings. The opportunity for a *post-mortem* examination after such an application of a new principle can only be occasional. If this woman at the time of her death had been under the care of some other surgeon than Lister, no such careful examination of the consequences of the tying of the artery would have been made, and no further progress would have followed. The result of Lister's examination showed that, in spite of his care, an incipient abscess was developing at the point at which he

had tied the artery. This was in consequence of the presence of the thread, and especially of the knot.

As a result of this investigation, on December 31, 1868, he tied the carotid artery in the neck of a calf with *catgut* which had been prepared with carbolic acid, and all antiseptic precautions were used during the operation. The calf recovered perfectly, and in thirty days was killed and the parts dissected. He found that at the site of the thread of catgut there was a band of living tissue surrounding the thread and closing the artery, and that, therefore, instead of the thread rotting through, as was the case with the silk, it had become a part and parcel of the tissues. The artery, instead of being so weakened as to allow of secondary hemorrhage, was really stronger at this point than at other points. The ligature and the knot had entirely disappeared.

I have narrated this somewhat in detail for this reason: It illustrates admirably the method of scientific progress by experiment upon animals. Neither of these animals suffered any material pain, both operations having been done with the same antiseptic care as in a human being. Both of them were killed at such a time as would facilitate our knowledge of the results.

Since then other experimenters have tied the blood-vessels in animals and have killed them at varying intervals and made microscopical examinations of the blood-vessels. In this manner our knowledge of the way in which hemorrhage is stopped is now complete. The knowledge which was attained within a short time by the sacrifice of a few animals would have been attained only after many years by occasional *post-mortems*, and would then have been very much less perfectly attained and only by the loss of many human lives instead of a few animals' lives.

Contrast, now, the result of the old and the new surgery in the mere matter of stopping hemorrhage after operations or accident by tying blood-vessels with the old ordinary silk and the modern antiseptic catgut, or with silk itself

as now used by improved methods. In the old way the blood-vessels were tied with silk, which was as clean as an ordinary housewife would have it. One end was left long, and it was no uncommon thing after an amputation of the thigh to have as many as twenty or thirty of these ligatures or threads hanging out of the wound. After two or three days, when those on the smaller blood vessels would, possibly have rotted through, each ligature was pulled upon, and those that were already loosened by putrefaction came away. Finally, at the end of ten days, two weeks, or three weeks, the ligature on the great blood-vessel of the arm or thigh came away, not uncommonly followed, as has been stated, by profuse and often fatal hemorrhage. Sometimes, as in Lord Nelson's case, such a ligature did not rot away for years, and required dressing of the arm all of this time on account of the constant discharge.

What happens to-day in a surgical operation where either properly prepared silk or catgut is used? We tie all the blood-vessels needing it, cut off both ends of the threads short and close the wound entirely; and, instead of having discharge and horrible inflammation for days and often weeks and sometimes months, it is now a rare thing for such a wound not to be entirely healed within ten days, and sometimes less, and secondary hemorrhage is almost unheard of. If vivisection had given to surgery only the modern means of stopping hemorrhage, it would be worth all the labor it has required and all the suffering it has inflicted on all the animals ever experimented upon.

Of late a new problem in hemorrhage has been presented. When an artery is wounded — as, for instance, if the blade of a pocket knife has been thrust into the thigh and wounds the great femoral artery — the only way to prevent the patient's bleeding to death has been to expose the artery and tie it above and below the point where it was cut. Of late several surgeons (especially Murphy, of Chicago) have made some very ingenious experiments on such wounded

blood-vessels. They have carefully exposed the artery of an animal (under an anesthetic, of course), have wounded it, and then, instead of tying the artery, have sewed up the wound in the wall of the artery to see whether this could not be done successfully. The reason for this series of experiments is this: When we cut off the supply of blood to a leg or an arm by tying the blood-vessels, gangrene not uncommonly occurs, because the chief blood-supply of the limb is cut off by tying the artery. If instead of tying the vessel we can sew up the wall and it will heal, the current of blood is uninterrupted and there is no danger of gangrene. One thing is perfectly manifest — it would never be proper to make such experiments on human beings. Human life would be endangered, and no surgeon would adopt or would be justified in adopting such a novel procedure until it had been tried and proved successful on animals. Several successful cases of suture (sewing) of the large blood-vessels have now been done in man.[1]

The Brain

When I first taught anatomy, thirty-five years ago, the various portions of the brain were not supposed to have separate functions. We knew, of course, that disease or an injury on one side of the head produced paralysis on the opposite side of the body. Broca also discovered by observations on man in actual cases of disease that when that part of the brain corresponding to the left temple was affected the power of speech was lost. But if a man had a fracture of the skull or a gunshot wound in the region above the ear or in the front of the brain or the back of the brain, there was no well-recognized difference in the results. This was largely due to the fact that such injuries are widespread, and not limited to small areas. In Germany, Fritsch, Hitzig, and Goltz, and in England, Horsley, Ferrier, Schaeffer,

[1] Now some hundreds of cases have been successfully operated on and patients doomed to lose leg or life have had both preserved. (1914.)

and others, pursued the following plan: The monkey's brain is the nearest in similarity to man's. A known portion of the brain — for instance, the region above the ear — being exposed, the brain was mapped out in small squares, and each one of these squares in succession had the pole of a battery applied to it. The phenomena which occurred — whether opening and shutting the eyes, turning the head right or left, contraction of the muscles of the arm or leg — were all carefully noted down. In this way a distinct map of the brain was made, so that we know definitely that a certain area of the surface of the brain governs the movements of the eyes, of the head, of the arm, forearm, hand, thumb, thigh, leg, great toe, etc. In the same way at the back of the head the area which governs sight has been found, and it was discovered that the area on the right side if destroyed made the right half of each eye blind, and that if the area of the left side was destroyed, the left half of each eye became blind. This description is, probably, sufficient to indicate how physiologists and surgeons have investigated the brain.

The following is an instance which shows how accurately this method has enabled us to locate the motor centers in the brain. A girl, who suffered from epilepsy, and in whom the convulsions always began in the right thumb, and then spread to the arm and the body, was operated upon. A piece of the gray matter on the surface of the brain, as large as the last joint of the forefinger, was removed from the place determined upon animals as the center governing the movements of this thumb. When she awoke from the ether *that thumb* but *no other part of the body* was entirely paralyzed. When we remember that the muscles which move the thumb arise in the ball of the thumb, between the thumb and the forefinger, and on the front and the back of the forearm nearly as high as the elbow, this is seen to be most remarkable. I do not know a single case ever recorded of so minutely located disease. By

no other means than vivisection could this small thumb center have been determined. She has entirely recovered from the paralysis, and her epileptic fits instead of being almost daily were reduced to one or at the most two a year.

Those experiments have made possible the modern surgery of the brain, which would not exist to-day were it not for vivisection. . . .

It is a source of sincere gratification on the part of numerous surgeons that by this same knowledge of cerebral localization derived from animal experimentation they have been able to recognize hemorrhage inside the skull, open the skull at the right point, even when there was no fracture of the skull, and save their patients. Before experiments on animals showed us how to interpret the symptoms this was an impossibility, and nearly all such patients died. Now we save, roughly speaking, two out of three!

Time and space would fail me to tell of the abscesses of the brain, of the foreign bodies in the brain (such as nails driven into it by accident or design, rifle-balls which had lodged in it), and of many other similar surgical disorders the modern successful treatment of which depends directly upon the localization of cerebral functions, which is the result almost wholly of experiments upon animals.

The Spinal Cord

Up to the present time the belief of surgeons has been that in case the spinal cord was completely cut in two, either by gunshot wounds, fracture of the spine or otherwise, no reunion of the two ends would take place, and, therefore, there was no possibility of relief for the paralysis below the point of division of the cord which is almost always fatal. Only this winter, at the Pennsylvania Hospital, Dr. F. T. Stewart had a patient whose spinal cord was cut in two by a bullet. He removed the bone sufficiently to get access to the spinal cord, and found it com-

pletely divided. He immediately stitched the two ends together, and, strange to say, this patient has recovered both feeling and motion to some extent in both legs. I think it would be evident to any person that such a totally unexpected result deserves the most careful investigation. In man cases of such complete division followed by recovery are almost unknown; and if they had to be studied in man, this would be imperfectly done, and probably would require fifteen or twenty years before we would know what ought to be done. It is one of those cases in which it is our duty to investigate by experiments upon animals what is the best method of sewing the two ends of the spinal cord together; at what date after division of the cord it will be hopeless to do so; how much of the cord can be lost (that is to say, a half inch, or more) and yet by stitching the two ends together it will be possible to restore the function of the spinal cord. One can see very readily that in animals all these problems can be studied minutely, in a sufficient number of cases; various procedures can be tested and the results determined accurately by killing such animals at a suitable date, and a definite conclusion can be reached in a short time.

In 1888 Mr. (now Sir Victor) Horsley, the distinguished London surgeon, and Dr. Gowers, equally distinguished as a neurologist, for the first time in the history of surgery made a diagnosis of a tumor of the spinal cord, definitely located it and the former removed it, the patient making an absolute recovery. A number of other cases have been successfully operated on since then. Just as in the case of tumors of the brain, this would not have been possible had it not been for experiments upon animals, which have given us practically most of our present knowledge of the minute anatomy and physiology of the spinal cord and have, therefore, enabled us to deal with it surgically.

Nerves

Among the most fruitful branches of research which have been so valuable in results are the animal experiments upon the different nerves of the body. The methods by which nerves could be sewed together; the possibility of taking a portion of a nerve or even of the spinal cord from a rabbit or other animal to replace a piece of the nerve when it has been destroyed by accident or disease; the possibility of sewing one nerve to a neighboring nerve in order to reëstablish its function — all of these and other similar operations have been studied in animals, and could only be studied in animals with exactness.

In order to study such conditions it is not enough that the two ends of the nerve should be sewed together and then, after the wound has healed, that we should simply determine the fact that the functions of the nerve are reëstablished. It is necessary to know by the microscope the various steps of the process of union of the nerves — to investigate various methods of sewing them together; whether they can be overlapped, or must be applied exactly end to end; whether one end of the nerve can be split and the other inserted into it, or turned over as a flap, and so on. Evidently numerous methods can only be studied on animals. Then, when the results are known, we can apply them for the benefit of man.

The Thyroid Gland

One of the commonest diseases in Europe, and one that is occasionally seen here, is goiter. This forms a large tumor in the neck, for which formerly little could be done, as an operation was nearly always fatal. Such patients were obliged to go through life with a dreadful deformity, in the greatest discomfort, and were sometimes suffocated by pressure on the windpipe. In consequence of the introduction of the antiseptic method of Lister, which we owe to vivi-

section more than to any other agency, operations on the thyroid gland are now so common that at the German Surgical Congress in April of this year Professor Kocher, of Berne, has reported two thousand operations done by himself, with a mortality of only four per cent.

Very soon it was discovered that removal of the entire gland produced a curious effect. The face became bloated; the expression greatly changed, and the patient became more or less idiotic — that is, the condition known as myxedema followed. This led to improvement in operations in several directions. First, in all those cases in which the tumor could be shelled out, as an English walnut is turned out of its shell, leaving a portion of gland tissue behind, this was done. The similar effects of the removal of the thyroid in animals were studied especially by Horsley. Surgeons then removed the thyroid gland from the neck of an animal and placed it under the skin of the same animal, and it was found that the disastrous results were avoided. After a number of experiments on animals there was good reason to believe that the disastrous effects of the operation which sometimes followed goiter could be avoided in man by the same procedure. Accordingly the thyroid gland of a sheep was transplanted in a number of instances under the skin, or in some cases into the abdominal cavity. In both cases there was improvement for a time; but eventually the majority of the cases suffered from cretinism or myxedema, which may be described as a less severe form of the same disease. Finally, in animals a study was made to determine how much of the gland must be left in order to prevent myxedema, and now we are able to relieve patients from goiter and yet, by leaving enough of the gland, prevent any bad results following the operation.

These results led also to a careful study of the effects of giving an extract of the thyroid gland to human beings. Some of the most brilliant results that have ever been ob-

tained in medicine have followed the administration of the thyroid extract to cretins in whom the disease had not been produced by operations for goiter, but arose naturally. In certain forms of goiter it has enabled us to relieve or even to cure without operation. In insanity and many other mental states it is used as a well-established remedy, which in even a large percentage of cases is followed by great benefit and even by cure. In many other diseases also the thyroid extract has been used with the best results.[1]

Removal of the Larynx

Cancer of the larynx, or that part of the windpipe back of and just below the Adam's apple, is not at all uncommon. The only hope for such patients is in removing the entire larynx or voice box. Before attempting this for the first time on man, Billroth, of Vienna, and his assistant Czerny, now the distinguished Professor of Surgery at Heidelberg, tested the operation on several dogs. Billroth then removed the larynx from his patient and saved his life. This operation has now been successfully repeated scores and scores of times as a result of these few experiments on dogs.

The Lungs

A beginning has been made in the surgery of the lungs, but as yet we have not reached the point where we can say that we have attained entire success. In a number of animals parts of the lungs have been cut out with a view of discovering the possibility of cutting out diseased portions of lung, the seat of tumors, consumption and other disorders, and a few operations have been done upon man, with a fair percentage of success. Not uncommonly abscesses of the lungs which were perfectly inaccessible a few years ago have been reached and opened. Sometimes coins and other

[1] For the later discovery of the use of the "parathyroid glands," see "Recent Surgical Progress," *post*, p. 166.

foreign bodies get into the bronchial tubes, and can only be reached through most difficult and dangerous operations. Several surgeons have experimented upon animals to determine the safest method of removing such bodies, but with only partial success. Is it not evidently our duty to devise new operative procedures and test them on animals first, and, when a reasonably promising one has been found, to apply it to man?[1]

The Liver

In 1890, Ponfick, of Germany, showed that in rabbits the removal of a quarter of the liver caused a slight deterioration in the condition of the animal; removal of one half was followed by much more serious symptoms, which, however, passed off within a few days. Even removal of three fourths of the whole liver could be recovered from, but removal of more than this was always fatal. By killing the animal in which a small part had been removed at a suitable time, and studying microscopically the liver tissue at different periods of time after operation — a procedure manifestly only possible in animals — he showed that there was a reparative power in the liver, which before then was unknown.

Up to that date less than a dozen surgeons had operated on tumors of the liver. In only two of them was any considerable portion of the liver removed. After the paper by Ponfick, which showed how much could be removed, surgeons immediately operated with much more confidence, and removed considerable portions of the liver. Up to 1899 seventy-six tumors of the liver had been removed. Of these cases the termination of two was unknown; of the remaining seventy-four, sixty-three recovered and eleven died — a mortality of less than fifteen per cent. One who is not a surgeon can scarcely appreciate how differently

[1] See the papers on "The New Surgery" (*post*, p. 171) and "The Influence of Antivivisection on Character" (*post*, p. 234) for the remarkable recent progress in the surgery of the chest.

the operation for tumor of the liver was regarded before and after Ponfick's experiments. Before that everything was marked by timidity; after that everything was marked by confidence, and all to the benefit of the patient.

The Spleen

The same story that has been told of the liver can be told of the spleen, though with much less good results. As a result of studies, partly by accident, in man (as when in consequence of a stab-wound or other injury a spleen would protrude through the wall of the abdomen, and would have to be removed), but chiefly as a result of the careful studies of removal of the spleen in animals, beginning practically with Schindeler's experiments in 1870, we are now in a position definitely to say that in man the entire spleen can be removed, and he can not only survive the operation, but can get along comfortably without any spleen. A very considerable number of such operations have now been successfully performed.

The Kidney

On August 2, 1869, Professor Simon, of Heidelberg, laid the foundation of the modern surgery of the kidney by removing a healthy kidney from a healthy woman. The reason for it was that in removing an ovarian tumor some time before he had been obliged to remove a part of the ureter (the tube leading from the kidney to the bladder), and to fasten the cut end to the skin. As a consequence of this the woman was in a most deplorable condition from the continual escape of urine over her person. After a number of unsuccessful attempts to close this external opening, it finally occured to him that the only way to cure her was to remove the kidney on that side. Whether a human being would recover and could live with only one kidney was practically unknown. It is true that disease had destroyed one kidney in some patients and the other had gradually

developed ability to do the work of both. Injury also had destroyed parts or all of one kidney, but deliberately to take out a healthy kidney from a healthy human being was an operation not only fraught with danger, but one before which all the surgical world up to that time had recoiled. No one had studied the effect on the remaining kidney and upon the heart. No one had carefully determined what was the best method of reaching the kidney — whether through the abdomen or through the loin from the back; what to do with adhesions and many other technical questions. All these had to be settled. Accordingly he experimented on a number of dogs; decided that from these indications a human being could live with only one kidney; studied on the cadaver the best way of doing the operation, and on August 2, 1869, removed this healthy kidney through the loin, saved the patient's life and made her perfectly comfortable. She died in 1877, after eight years of healthy life.

As I have said, these new experiments laid the foundation of the modern surgery of the kidney. Now hundreds of kidneys have been removed successfully. Finding this operation so feasible, surgeons were led to practice other operations; some hundreds of abscesses in the kidney have been opened; stones have been removed from scores of kidneys; floating (i.e., loose) kidney has been sewed fast in hundreds of cases; many cases of tuberculosis of the kidney have been relieved or cured; tumors of the kidney are successfully attacked; even the cut ureter has been spliced; stones also have been removed from it. In a word, Simon's experiments on a few dogs opened to us a new domain in surgery which until then was wholly unknown. Would it not be gross cruelty to man to prevent such beneficent researches?

The Stomach

Were I limited to the progress of the surgery of the stomach alone by vivisection there would be quite enough ma-

terial for this entire paper. Until 1875 practically there was no surgery of the stomach. As occasional Cæsarean sections have been done in the past, so occasional operations on the stomach were done when the surgeon was obliged to do them. Now, however, it is a matter of routine procedure, to the vast benefit of the human race. Had vivisection contributed nothing else to the progress of surgery than its services in the surgery of the stomach, this alone would be sufficient to justify it. I may quote from the Cartwright lectures which I gave before the College of Physicians and Surgeons in New York in 1898:[1] —

In 1875, Tschertneisky-Barischewsky cut out a piece of the intestines in thirty-five dogs, with twenty-nine recoveries — a startling result when compared with the former fatality of such operations. This was the starting point in the new gastro-intestinal surgery. The next year Gussenbauer and Winiwarter cut out a piece of the stomach in only seven dogs. We scarcely can appreciate at this day, though these experiments are so recent, how many new questions had to be answered. After their first unsuccessful experiment they naïvely remark that certain facts were established by the experiment, among them, "that the surfaces of the stomach have a real tendency toward union by first intention, . . . just as do wounds of the skin." (!) Whether this would be correct of man as well as of animals they admitted was as yet uncertain. Another point settled by the experiment was "that there was no digestion of the mucous membrane in the neighborhood of the wound." Their second experiment was followed by recovery, and showed not only that such an operation could be successfully done, but that the narrowing caused by the scar did not interfere with the functions of the stomach, either as to its movement or its secretion of the digestive juices, and that the removal of the pylorus (the opening from the stomach into the intestine) was not followed either by the too early escape of the food into the intestines, or by the reflux of the intestinal contents into the stomach. The dog was killed five months later and the *post-mortem* showed no contraction, by reason of the scar, and no digestion of the edges, and his perfect health after the operation showed that the movements of the stomach and its digestive

[1] In quoting this I have popularized some of the medical terms there used.

functions had not been interfered with. Then, again, the question whether catgut or other suture material was the best, and what kind of a knot and what kind of a suture would best answer were subjects of debate.

Our antivivisection friends, who so often declare that experiments upon animals have never contributed anything to the progress of surgical science, may well be challenged to account for the remarkable progress in the surgery of the stomach which immediately followed these fruitful experiments. The dogs that died did not die in vain. They showed the correct methods and indicated errors in technic, and directly led up to the modern surgery of the stomach and the intestine in man, as follows: In the very same year, 1876, Hueter cut out a part of the bowel, though without success. In 1877 Czerny for the first time sewed up the intestine, and dropped it into the abdominal cavity, with recovery; followed almost immediately by Billroth, who did the first successful suture of the stomach and total removal of a portion of the bowel. In 1878 Forelli operated for a wound of the stomach, and in 1879 Cavazzani removed a portion of the stomach for tumor. In the same year Péan did the first removal of the pylorus. In 1880 Rydygier did the second, and in 1881 Billroth did the third and first successful one, without a knowledge of the preceding operations.

Then followed various operations on the stomach to which I will allude later, and finally the successful removal of the entire stomach. It is quite impossible to give the details of all the various operations now done on the stomach and indicate minutely the part that vivisection has had in developing this extraordinarily successful branch of modern surgery. Suffice it to say that among them are the following, all of which owe more to vivisection experiments than to any other single agency: —

In cancer of the esophagus or in the constriction of the esophagus, which so often follows the accidental or intentional swallowing of lye or acids, etc., so that no food can get *into* the stomach, we now open the abdomen, open the stomach, introduce a tube or construct a passageway into the stomach, and feed the patient through this outside esophagus, as it were. In case the narrowing of the esoph-

agus is not from cancer the patient can live his natural span of life. In case of cancer his remaining days are rendered relatively comfortable, since the operation prevents his starving to death. When we have cancer at the opposite end of the stomach (the pylorus), so that the food, though it can be swallowed, cannot get *out of* the stomach, one of two courses is followed, both of which have been carefully studied in the lower animals and then adapted to man. First, the portion of the stomach and bowel involved in the cancer is cut out and the bowel united to the stomach directly, or, in other cases, an opening is made in the stomach and one in the bowel lower down, and the two openings are sewed together, thus allowing the food to pass from the stomach directly into the bowel beyond the cancer. The mere question of how the stomach and bowel can be most successfully united in these cases, particularly the best method to prevent fatal leakage, has required very many series of experiments, especially in this country, by Senn, Abbe, Brockaw, Ashton, Murphy, and others. As a result of their labors sometimes we have learned how *not* to do the operation because of unexpected difficulties; sometimes how to better our procedure, until now we are in possession of satisfactory methods, as has been proved by the successful operations on man many times over. Even the sewing together of the stomach and bowel alone had been done up to 1898 in 550 cases which have been published. I have no doubt that since then this number has almost been doubled. The mortality of this operation from 1881 to 1885 was 65.71 per cent; from 1886–90, the mortality had fallen to 46.47 per cent; from 1891 it had again fallen to 33.91 per cent, and recently in twenty-seven cases an Italian surgeon (Carle) has had a mortality of only 7.4 per cent.

Moreover, the experiments on animals, having shown how safe various operations are, have emboldened us to enlarge the sphere of our operations and do others that

were before not dreamed of—a good instance of the partly indirect good results from vivisection.

A brief enumeration of some of the various operations done upon the stomach, together with their mortality, is as follows: —

(1) Where the stomach is bound down by adhesions (which often produce the most serious digestive disturbances, destroying comfort and even threatening life), we now open the abdomen, cut or tear the adhesions, and practically all of the patients recover.

(2) Where there are foreign bodies in the stomach (or in some cases foreign bodies that have stuck in the esophagus low down, near the stomach), we open the stomach, remove the foreign body (inserting, if need be, the arm to reach it in the esophagus), sew up the stomach and the abdominal wall, and the patients generally recover. In some cases as many as 192 staples, buttons, screws, horseshoe nails, etc., weighing over a pound and a half, have been removed, and the patients have recovered.

(3) Where the esophagus has been narrowed by the swallowing of lye, etc., instead of making a permanent opening in the stomach (as before described), sometimes by having the patient swallow a perforated shot which will carry a string down into the stomach, we can open the stomach temporarily, seize and draw out the shot, attach a conical dilator to the string, and, after having dilated the constriction of the esophagus, remove the string, sew up the stomach and the abdominal wall and cure the patient permanently.

(4) We now open the stomach purely to explore it and find out whether or not there is serious disease. This has enabled us in many cases to relieve illness which otherwise was incurable. Nearly all of these patients recover from the operation.

(5) The permanent opening in the stomach through which we can feed a patient I have already described. It

was first proposed in 1837. It was first done in 1849. From then until 1875 twenty-eight cases were operated on, with twenty-eight deaths! It seemed almost as though the operation must be abandoned when, in 1875, the first operative recovery occurred. From then until 1884 in 163 cases there were 133 deaths — a mortality of 81.66 per cent. At the present time the mortality is only about twenty-five per cent in cases of cancer, and in the non-malignant cases not over ten per cent.

(6) As I have indicated, in certain conditions we make an opening in the stomach and another in the bowel and sew the two openings together. In some cases of ulcer of the stomach, which cannot be cured by medical means, this gives wonderful results, both as to comfort and cure. The operation was first done in 1881, with a mortality decreasing from 65.71 to 33.91 per cent in general, and in the statistics of single surgeons to only 7.4 per cent.

(7) The first removal of the pylorus with union of the bowel and stomach was done in 1879. The mortality was very great, and is still large, ranging from 27.2 per cent in simple cases to 72.7 per cent when there are extensive adhesions.

(8) When the pylorus is simply narrowed, but is not the seat of cancer, we make an incision in its long axis, seize the edges of the incision at the middle, draw them out at right angles to the line of the incision, and by sewing them in this position we widen the opening of the pylorus. This was first done in 1886. Up to 1894 the mortality was 20.7 per cent. Recently Carle has reported fourteen cases, with a mortality of only seven per cent.

(9) In not a few disorders the stomach is dilated to nearly two or three times its normal size. In these cases we now take a "tuck" in it, as was first done in 1891. Up to three years ago fifteen such operations had been done, with only one death.

(10) When the stomach, instead of being dilated, is dis-

placed, we sew it fast, and practically in all cases recovery follows.

(11) Sometimes the stomach is divided into two parts, like an "hour-glass" or a dumb-bell with a very short handle. The first operation for relieving this condition was done in 1893 by making an opening in each half of the stomach and sewing the two openings together. Up to this year over forty operations have been done for this condition, with only nine deaths.

(12) Tumors of the stomach other than cancer are rare, but since 1887 at least seven cases of tumor have been cut out, of which six have recovered.

(13) Partial removal of the stomach finally led to its complete removal, of which over a dozen instances have been reported, with a recovery of somewhat more than half. Nearly all, however, have died from recurrence.

Some of the above operations are not the direct result of experiment upon animals (as, for instance, the taking of a tuck in the stomach); but they are the indirect result, first, through the antiseptic method, which itself is the child of vivisection, and, secondly, because through our experience in other operations we have been led to perform totally new ones. It is the same in other sciences. If we were still dependent upon the old "air-pump" worked by hand, we should have no lighting by the incandescent bulb of to-day, for this is dependent upon a cheap method of making an almost complete vacuum. This is a wholly unexpected and indirect result of improvement in air pumps as one of the chief factors of progress.

The Intestines

Very much the same story can be told of the surgery of the bowel. Indeed, the surgery of the stomach involves largely that of the bowel. I need, therefore, only recall a very few points. When a tumor or cancer exists in the bowel, of course, in a little while it obstructs the passage of

the intestinal contents; and if this obstruction becomes complete and is not quickly removed, the patient must necessarily die. As a result of many experiments upon animals (more especially by Senn, Parkes, and other American surgeons) we now know how to deal with this condition. First, if the tumor or cancer can be removed, it is cut out entirely, and the two ends of the bowel are united. Our present successful means of uniting them are a result of most laborious researches by experimentation upon animals to discover the best method of doing this otherwise perilous operation. The slightest leakage of intestinal contents produces a fatal peritonitis. Where the cancer cannot be removed, in order to prolong the patient's life and lessen his terrible pains, we make an opening above the obstruction and another one below and sew the two openings together. Here again many experiments were needed to determine whether an animal could live with the intestinal contents thus "side-tracked," and if life could be maintained, what was the best method of doing the operation.

In gunshot wounds of the intestines, which formerly were among the most fatal of all accidents, we now can rescue a very large percentage of the patients. During the Civil War practically almost every case of perforation of the intestine by gunshot died. To see whether something could not be done to remedy this frightful mortality, Gross many years ago performed some experiments to determine the best treatment of such wounds. Later Parkes etherized a number of dogs, shot them, opened the abdomen and treated the wounds in various ways; and in consequence of this and other series of experiments, at the present time many instances of recovery have been reported in which multiple wounds even to the number of seventeen have been found closed by methods determined by vivisection to be the best, and the patients have recovered. To reach this result it had to be determined by accurate observation on animals what was the best method of closing such

wounds; what material is the best for use as a thread; under what conditions it would be needful, instead of closing the wound, to cut out the injured portion of the bowel and unite the two ends; how long after perforation occurred was the best time to operate, and many other such questions too technical to mention here.

In typhoid fever and in ulcer of the stomach also sometimes a perforation similar to the hole made by a bullet occurs, and the contents of the intestines or of the stomach are poured out into the abdominal cavity. Of course, every one knows that if this went on for a brief time death would necessarily follow. In the lower animals we cannot produce exactly the conditions following gastric ulcer and typhoid fever; but, in consequence of the knowledge acquired by experimenting upon gunshot and incised wounds of the stomach and bowel in the lower animals, in 1884, we finally woke up to the fact that a perforation after such an ulcer, either in the stomach or in the bowel from typhoid fever, ought to be closed. In 156 cases of such perforation of the stomach operation has been done, and the recoveries have been 46.80 per cent. But in the last 54 of these operations done from 1896 to 1898 the percentage of recoveries had risen to 64.82 per cent. In 158 such operations done for perforation of the bowel in typhoid fever collected in 1898 the recovery rate was 23.41 per cent. Since then it has risen to over one in three, and ultimately, I believe, one half of such patients will be saved. It must be remembered that in such perforations of the stomach and bowel every patient would die were no operation done. To save one half or even one third is a surgical triumph.

I have several times alluded to cutting out a portion of the bowel and uniting the two ends. This involves a number of problems which ought not, and, in fact, cannot, be studied in man because of the fact that it is wholly inadmissible to test such operations (which always involve life) on man when they can be tested accurately and more

quickly by experiments on animals without involving human life.

I have stated that by many experiments on animals we have now reached a satisfactory solution of the problem how the two ends of the bowel are best sewed together. But one other question was still unanswered — how much of the bowel could be removed and yet life be preserved. A similar question, we have seen, has been answered in respect to how much of the liver could be removed by Ponfick's experiments. How much of the bowel could be removed was a most important question. We would all presume that a few inches, possibly even a foot or two, might be removed without danger; but when we remove a larger portion we cut down the digesting and absorbing surface to such an extent that it is a question whether the patient can still live. This has been determined upon animals, and then, as occasion required us to decide the question, in man. As a result of the knowledge derived from animal experimentation I saw four years ago in Montreal a man from whom Shepherd had removed eight feet (over one third of the entire length of the bowel) which was involved in a large tumor; and yet the patient was in capital health a long time after the operation.

Hydrophobia

The search for the germ of this dreadful disease has as yet been fruitless; but happily the search for the means of prevention has been crowned with success. Before Pasteur, of every hundred persons bitten about fifteen contracted hydrophobia and *every one* died. Of those bitten on the head and face at least eighty per cent contracted hydrophobia and again *every one* died. The Pasteur treatment, which is entirely the result of animal experimentation, by preventing its occurrence, has reduced the mortality to *less than one per cent;* and yet the establishment of Pasteur Institutes for the benefit of the human

race has been resisted most strenuously by those opposed to vivisection.[1]

Transplantation of Bone

In 1867, Ollier, a celebrated French surgeon, who recently died, by experiments on animals showed that the membrane which covers the bones (the periosteum) could be peeled off a bone and transplanted to a distance into the tissues of the same animal, or even of another animal, and that it would there live and produce new bone. These experiments, very crudely described in these few words, have been extraordinarily fruitful in several directions.

First, in certain cases it is necessary to remove diseased or dead bone. These experiments showed us that if in removing the bone the periosteum was carefully guarded and left behind it would reproduce the bone. In some cases in which the lower jawbone has died as a result of phosphorus poison in the employees of phosphorus match factories, the dead bone has been removed, but the periosteum has been preserved and a new jawbone has been reproduced. Another result has been that, instead of amputating, for example, an arm when the elbow is diseased, we can remove the bone and by preserving the periosteum can preserve a more or less useful joint.

In other cases a certain area of bone, as, for instance, in the skull, is chiseled loose or otherwise separated from the surrounding bone excepting for an inch or two at the portion where the chief blood supply enters the flap. The bone is then forcibly broken at this unchiseled portion and turned back, the periosteum and scalp acting as a hinge. When the tumor has been removed, the abscess opened, or other needful operation done, the trap door is simply closed by replacing the flap of bone, the scalp sewed in place and

[1] In spite of the wearisome reiteration of Dr. Charles W. Dulles that there is no such disease as hydrophobia, the actual germ of the disease has just been discovered at the Rockefeller Institute. (1914.)

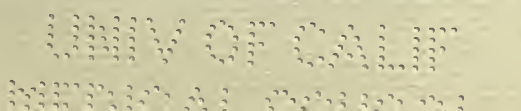
the integrity of the skull is restored. One can see that this is an immense advantage over having a great hole left in one's skull.

In some cases, in which, in consequence of accident or abscess, a large hole already exists in the skull, we either chisel off bits of adjacent bone or take pieces of bone from one of the lower animals and successfully fill this opening.

Again, in certain cases, for example, in which the jaw has been fractured, a bit of the bone has been chiseled loose from the patient's jaw and has been grafted in place as a bridge between the two fragments, so relieving the deformity or remedying an otherwise incurable fracture.

Again, a certain small number of children are born without any bone at the back of the spine in the neck or the loin (*spina bifida*). Through this opening the membranes of the spinal cord protrude and form a tumor which, if untreated, in most cases proves fatal. We now operate most successfully on many of these cases, and in suitable cases either chisel loose a bit of adjacent bone and transplant it, so as to close the opening, or in other cases take a bit of bone from one of the lower animals to fill the opening and cure the patient.

Again, in certain cases of fracture of the arm bone (humerus), the nerve going to the muscles on the back of the forearm, which winds close around the bone on a spiral, is torn in two; these muscles are paralyzed, and the patient has what we term "wrist drop," so that the hand is useless. In such cases the knowledge derived from two different series of experiments comes to our aid to enable us to remedy the trouble. First we expose the two ends of the broken nerve, freshen these ends, unite them, and in many cases can change a useless hand into a useful one; but if so much of the nerve has been destroyed that the two ends cannot be brought together we now deliberately remove an inch or two of the arm bone, thus shortening the arm so as to



bring the two ends of the nerve together, unite them, wire the two ends of the bone together, and in a good percentage of cases we can again restore the hand to usefulness after months and occasionally even after years.

A still more remarkable transplantation of the bone is accomplished in some operations on the skull. In some cases it is necessary to remove a button of bone which may be an inch and a half or two inches in diameter in order to do an operation on the brain. The operation which has necessitated this removal of bone may require an hour and a half or two hours. If we want to replace the bone so as not to leave an opening in the skull through which the brain may easily be dangerously injured, we put the button of bone in a basin of hot salt solution or weak antiseptic solution, and by keeping it at a proper temperature, at the end of the operation, when it has been totally detached from the body for so long a time, we replace it and its vitality is not lost.

All of these various operations (and others which I have not time to describe) done on bone, to the immense advantage of our patients, are the direct or remote results of the experiments of Ollier and others on the transplantation of periosteum and of bone. The indirect results are quite as valuable as the direct results of such experiments, and sometimes more valuable.

An illustration of the indirect results of Ollier's experiments is shown in the transplantation of the skin. One of the oldest operations in surgery is the making of a new nose. When the nose had been lost a suitable shaped flap was cut on the forehead, leaving a sufficient uncut base for a proper blood supply so that the flap would not undergo gangrene. The flap was then turned by twisting it on its base and was sewed in place where the nose had been. The experiments of Ollier and his successors showed, however, that periosteum, and even so dense a structure as bone, could be entirely detached from the body for a long time and yet not lose its vitality. Hence we now transplant bone as well as

skin to make firm instead of flabby noses. This has led us of late years to apply the same procedures to the skin, and enables us now to do far more extensive and more successful operations than would otherwise have been possible. The first method tried in man was that of Reverdin, of Geneva. He cut little bits of skin only as big as a pin's head from the arm or the thigh, not quite skin deep, and planted them on any raw surface which did not heal readily. These grafts under proper treatment adhere and form new centers from which healing of the wound takes place. Emboldened by this, Krause and other surgeons have taken very large pieces of skin, including often the whole thickness of the skin, detached them entirely, and transplanted them. For example, in some cases of extensive cancer in which a very large portion of skin must be removed, now, while the patient is under the influence of the anesthetic, we take strips of skin an inch wide and several inches long from the thigh of the patient during the operation, or, in other cases, from another person who is willing to give up a portion of his skin. These pieces are immediately placed on the raw place left by the removal of the cancer, and as they do not lose their vitality but grow fast to the tissues under them, the wound is healed almost immediately, instead of taking a long time for the slow formation of a scar.

One of the most difficult of all wounds to heal is an extensive burn, such as is produced by the clothing catching fire. In these cases large surfaces of the skin on the chest or the abdomen slough off, resulting in great ulcers. These sometimes take months, sometimes years to heal, and in not a few cases never heal, no matter what is done. Now, as a result of our experience, first with the periosteum and bone and then with small bits and then larger bits of skin, we transplant strips of skin as just described, and such wounds heal in a very short time. One sees in the newspapers every now and then accounts of some woman whose long hair has been caught in machinery and almost all of

the scalp torn away. These wounds are healed by transplanting skin in a similar manner.

The Blood

We are at present only just beginning to appreciate how much we can learn from examination of the blood, especially by new methods lately introduced. Almost every intelligent person knows that the blood consists, roughly speaking, of a fluid in which float small circular disks, about one three-thousandth part of an inch in diameter, called the red blood cells. In addition to these there is in the blood another kind of cell called the white blood cell. The red blood cells are made up chiefly of a substance called hemoglobin, which gives the color to the blood. Some of the investigations, which are really only at present at the beginning of their usefulness, are as follows. They are good illustrations of how inductive science begins by ascertaining facts. If they are valueless they are disregarded; if of value they are studied still further. It is not unlikely that the blood may soon be one of the most fruitful sources of the knowledge by which surgery may profit greatly.[1]

First, the *number* of white blood cells. It is found that in case inflammation results in an abscess the number of white blood cells is increased several times. Ordinarily in a little cube of blood one millimeter (the twenty-fifth part of an inch) on each of its sides the number of red blood cells is about four to five millions, and the number of white blood cells is eight thousand to ten thousand.

If one has an abscess, the white blood cells as a rule will rise to fifteen thousand, twenty thousand, twenty-five thousand, or more to the cubic millimeter — a condition that we know scientifically as "leucocytosis." In certain cases when it is a question whether an abscess exists (as, for instance, in the brain, in the liver, and other parts of

[1] Immense progress in the study of the blood has been made in the thirteen years since this was written. (1914.)

the body in which the diagnosis is very difficult to make), if the leucocytosis or its absence will show us absolutely that there is or is not an abscess present, it would be of the greatest help.

Again, in typhoid fever the pain and tenderness exist just above the right groin. In appendicitis the pain and tenderness exist in the same region, and in not a few cases it is extremely difficult to distinguish between these two diseases. Especially is this true at the beginning of such an illness, just when it is most important to make the right diagnosis and institute the correct treatment. If the presence of leucocytosis will show us distinctly that it is appendicitis, and the absence of leucocytosis that it is typhoid fever, an immense gain in accuracy of diagnosis, and, therefore, of the proper treatment, will result. To open the abdomen, if it is typhoid fever (without perforation), would be a dreadful mistake; not to open it, if it is appendicitis, would be, as a rule, equally wrong treatment. If the leucocytosis is a sure guide we cannot learn it too quickly. It seems to me very reasonable, therefore, that experiments should be made in the lower animals by producing abscesses and determining whether under many varying conditions leucocytosis is always present when there is an abscess and always absent when there is no abscess.[1]

Second. Hemoglobin. The hemoglobin, which makes up the bulk of the red blood cells, is the means by which oxygen is carried to all parts of the tissues. Whenever an anesthetic, such as ether or chloroform, is given, the amount of hemoglobin is distinctly diminished, and by this means the oxygenation of the blood is hindered. In certain conditions of the system the percentage of hemoglobin is diminished to sixty, fifty or even as low as twenty-five per cent of the normal. If an anesthetic is given to a person with an already diminished percentage of hemoglobin this percentage is still further diminished, and the oxygenation of the blood

[1] This is now a constant and valuable means of diagnosis. (1914.)

still further hindered. If, then, the percentage of hemoglobin is very small before an operation, the danger of giving an anesthetic is very marked; if the hemoglobin is as low as thirty per cent, it is very likely that the patient may die upon the table irrespective of the operation, simply because the anesthetic reduces the hemoglobin to such a point that the blood does not absorb enough oxygen to carry on life. Some authorities have stated that we ought never to give ether or chloroform to a patient whose hemoglobin is below fifty per cent. Others have placed the limit as low as thirty per cent. Surely this subject, which is very recent and about which we know up to this time very little, ought to be investigated with the greatest care in animals rather than to decide the question by sacrificing life by venturing to give an anesthetic to patients whose hemoglobin is at so low a point as to be inconsistent with safety.

Other recent researches are those on the temperature at which the blood freezes and the lapse of time after the blood is drawn from the body before it coagulates — that is, clots. A small portion of blood drawn by a prick of the finger enables us to determine these four conditions — i.e., (1) the presence or absence and degree of leucocytosis; (2) the percentage of hemoglobin; (3) the freezing temperature of the blood, and (4) the coagulation time of the blood. We are beginning to see that these last two as well as the first two will probably prove of the greatest value in reference to surgical operations. Hence we ought to learn accurately and quickly all the facts in the case by experiments upon animals, and so avoid dangers to human life of which until lately we have been quite ignorant.

These would include experiments upon animals fasting, or after feeding; after being bled; after surgical operations have been done upon them; after an anesthetic is given to them; when the anesthetic is administered for a short time, for a longer time, for a very long time, or for a time long enough to kill them, in order to determine what the effect

of the anesthetic is in fatal and non-fatal doses. It is of the utmost importance that we should know exactly and speedily the result of all these conditions. If we are debarred from learning them by experiment on animals, then the human race must go without the knowledge we seek, saving as it is revealed to us from time to time by studying slowly and inexactly the results in man. With certain modifications due to the slight differences between man and animals the conclusions drawn from experiments on animals apply to man.

Let me give one instance which confronts the surgeon not infrequently. An abdominal section is occasionally followed by very great and, it may be, dangerous and alarming depression. One of the most difficult things to determine in some cases is whether this condition is due to the shock of the operation or to internal hemorrhage. This hemorrhage differs from that which may follow an amputation or removal of a tumor from the neck, etc., by the fact that it is concealed within the abdomen, and its existence can only be inferred. If the patient is suffering from shock, stimulation, heat, quiet, certain drugs, etc., will be resorted to to enable him to recover. If it is due to internal hemorrhage, we must instantly reopen the abdomen and tie the bleeding vessel. To do the latter operation when the patient is only suffering from shock might prove fatal; not to do it, if hemorrhage is the cause of the depression, is certainly fatal. No one not a surgeon can appreciate the anxiety, the careful weighing of evidence, the intense longing for some positive means by which a correct diagnosis may always and surely be made, which every surgeon feels in such an emergency.

It is possible that by examining into the presence or absence of leucocytosis, by determining the percentage of the hemoglobin, or possibly even the coagulation time and the freezing temperature of the blood in a number of operations in human beings, we might be able positively to de-

termine the difference between shock and internal hemorrhage, but only after making many blunders, each of which would cost a human life: every life so lost would be a needless sacrifice upon the altar of antivivisection. In an animal we can open a blood vessel in the abdomen and let it bleed for a longer or shorter time, and determine positively the leucocytosis, the hemoglobin, etc., the animal meantime suffering nothing because it would be under an anesthetic. Which is the right, which the kindest, which the most humane way of finding out the truth? This is an illustration of the harmlessness to animals of such experiments and their priceless value to human beings.

Experiments to enable us to make a Reliable and Speedy Diagnosis

In some cases in which the diagnosis is difficult, or may require considerable time, experiment upon animals aids us greatly, and so is of immense value to man. Thus in supposed anthrax, or wool-sorter's disease, a most dangerous malady, by inoculating a guinea pig with the discharge the diagnosis can be cleared up quickly and proper treatment instituted. If a case suspected to be one of bubonic plague arises, the diagnosis can be established within twenty-four or thirty-six hours by a similar injection into a rat or a guinea pig, the apprehensions of a community (to say nothing of the patient and his friends) relieved and the greatest damage to its commerce averted by discovering that it is not the dreaded pestilence, or, if it is the plague, by showing the necessity for most stringent measures to prevent its spreading. I do not think any community will or ought to allow sympathy with the unavoidable suffering of a few rats or guinea pigs to weigh in the balance for a moment against the safety of many human lives and the ruin of large business interests.

An amusing instance of how sentiment gives way before

affection and facts occurred not long since in England. The brother of the Duke of Newcastle was bitten by a dog supposed to be rabid. The Duke was president of the Anti-vivisection Society, but knowing that whether the dog was rabid or not (and, therefore, whether his brother was in danger or not) could only be settled by inoculation experiments upon animals, he took the dog to Horsley, in London, and had the experiment done. He was promptly deposed from his presidency.

By similar means anthrax and actinomycosis (or lumpy-jaw, which spreads to man as well as to herds) among cattle are diagnosticated and eradicated; glanders in horses is recognized and stamped out and tuberculosis in cows is eradicated, not only preventing its spread to healthy cattle, but through the milk to many human beings, especially young children, whose chief diet must be milk.

By similar experiments on animals the causes of chicken cholera, hog cholera, Texas fever, and many other diseases of cattle, sheep, horses, hogs, poultry, and other animals have been discovered and the means of prevention or of cure demonstrated. The Reports of the Bureau of Animal Industry at Washington enter into these in detail. Surely the poor animals who have benefited so greatly from such experiments should pray to be saved from their friends if these beneficent researches are to be prohibited.[1]

I often wonder what would have been the influence on surgery if the young man who first took ether in the Massachusetts General Hospital on October 16, 1846, had died. Morton, it is true, had experimented on some dogs first, but, as we now view it, very inadequately. Had this patient died, would not the use of ether have been deferred for years, possibly even till now, and meantime the human race all over the world have gone on suffering the horrible tortures of the pre-anesthetic days and all our modern progress in surgery have been prevented? I hardly ever

[1] See Pamphlet No. 6 in the List on p. xix.

look on my patients in the blessed ether sleep without being impressed with the confident audacity of the earlier operators who dared to induce a sleep so like that of death when they must often have asked themselves whether the patient would ever waken or whether this was not the first stage of the never-ending sleep.

If the sacrifice of the lives of even a considerable number of animals enables us to reach the benevolent purposes, a few of which I have described, is it not plainly a moral duty to perform them so as to obtain this knowledge? Is it not wrong to hinder such benevolent researches? Especially is it not wrong so to hinder research when, in the vast majority of instances, animals suffer little or nothing? In almost all experiments not only can an anesthetic be used, but in all involving difficult and delicate operations it is essential to do so; for it is impossible to do such an operation on an animal struggling from pain. Not only, therefore, does sentiment lead the vivisectionist to spare the animal all the suffering that is possible, but scientific accuracy points in the same direction. A very few experiments, principally those on the nervous system which require us to determine the presence or absence of sensation, cannot be done with an anesthetic; but these experiments are few and far between. Some experiments also (for instance, those on lockjaw, to which I have already alluded) by producing the disease, necessarily make the animal suffer; but if by the suffering of a few animals, human beings suffering from lockjaw can be cured, or, still better, if we can learn the cause of the disease and so can prevent it from attacking human beings, is it not worth the suffering? The infliction of suffering is not cruelty. If one dear to us meets with an accident far away from surgical aid and we spur a horse to the utmost so that finally it drops dead in our frantic effort to bring surgical assistance, I am sure no one would accuse us of cruelty, although we had inflicted torture upon the horse. So this infliction of pain on a small percentage

of animals experimented on is not cruelty, but is the greatest kindness to other animals and to a much higher animal — man himself.

I have been able in this paper to select only a few illustrations of the progress that surgery has made by experimentation on animals. Practically, as I said at the beginning, nearly all of these have occurred during my own professional life, and I speak, therefore, of what I know. Although I myself am not a vivisectionist, yet I could not do the work I do every day and accomplish results I obtain were it not for just such work, of which I take advantage. In view of these facts, therefore, how unwise it would be to restrict and still more to abolish such life-giving and pain-saving results of vivisection, especially when the animals themselves benefit from these experiments fully as much as man. I have not referred to any of the older experiments, such as those remarkable experiments of Jones on the methods of tying blood-vessels in the early part of the last century, nor of Sir Charles Bell's experiments, by which he determined the functions of the two different roots of the nerves just as they emerge from the spinal cord, nor of the circulation of the blood as discovered by Harvey. All these are fundamental; and without the knowledge derived from them we should be a century or more behind where we are now. I have preferred rather to take modern instances with which I am personally familiar in order to illustrate the subject which I have been asked to describe. I cannot believe that any unprejudiced, fair-minded reader will not agree with me that such humane purposes should be fostered and not hindered; should be encouraged and not abolished.

MISSTATEMENTS OF ANTIVIVISECTIONISTS

CORRESPONDENCE WITH THE AMERICAN HUMANE ASSOCIATION[1]

LETTER FROM THE PRESIDENT OF THE AMERICAN HUMANE ASSOCIATION[2]

Toledo, Ohio, Oct. 4, 1900.

Professor William W. Keen, late President of the American Medical Association, Jefferson Medical College, Philadelphia.

Dear Sir, — My attention has just been called to a passage in the published "Report of the Hearings" before the Senate committee, held at Washington last February, on the bill for regulation of vivisection. In this volume the following conversation between Senator Gallinger and yourself is recorded: —

Senator Gallinger — What knowledge have you of the advances made by vivisectionists that have led them to progress from the brute creation to the human creation in making these so-called vivisection experiments?

Dr. Keen — I presume that you refer to a pamphlet issued by the American Humane Society. I have only to say in reference to it that there were a number of experiments which I would utterly condemn. Of the experiments narrated in that pamphlet, I have looked up every one that I could. Only two are alleged to have been done in America. Many of them are so vague and indefinite that I could not look them up, but as to those that I could, some are garbled and inaccurate; not all of them, observe.

Senator Gallinger — Some of them?

Dr. Keen — Some of them.

[1] Reprinted by permission from the *Journal of the American Medidal Association* for February 23, 1901.

[2] Printed by permission.

A statement of this character, based upon such authority, it is impossible to ignore. Proceeding from one less eminent than yourself in that profession which you represent and adorn it might pass without notice, but coming from you, sir, such a charge must be investigated and probed to the fullest extent. Its importance is evident, and in testing its accuracy you will give me, I trust, every assistance within your power.

First: Regarding the cases of experimentation upon human beings recorded in our pamphlet, "Human Vivisection," you informed the Senate committee that "*many of them are so vague and indefinite that I could not look them up.*" We challenge the accuracy of that statement, and ask for proof. Of the various series of experiments upon human beings, made for the most part upon women and children in hospitals and infirmaries, the authorities given in this pamphlet are as follows: —

1. Bulletin of the Johns Hopkins Hospital, July, 1897.
2. *Boston Medical and Surgical Journal*, August 6 and 13, 1896; *Philadelphia Polyclinic*, September 5, 1896.
3. *New York Medical Record*, September 10, 1892.
4. *British Medical Journal*, July 3, 1897; *New England Medical Monthly*, March, 1898.
5. *Medical Press*, December 5, 1888; *British Medical Journal*, August 29, 1891; *London Times*, June 27, 1891; and other journals.
6. *Medical Brief*, June, 1899.
7. Ringer's *Therapeutics*, pp. 498, 503; 585, 588, 590, 591, *The Lancet*, London, November 3, 1893.
8. Newcastle *Daily Chronicle*, September 21, 1888.
9. *Medical Press and Circular*, March 29, 1899; *The Lancet*, London, May 6, 1899, p. 1261.
10. *Allg. Wiener med. Zeitung*, nos. 50 and 51.
11. *Deutsche med. Woch.*, nos. 46–48, 1894.
12. *Ibid.*, February 19, 1891.
13. Lecture before Medical Society of Stockholm, Sweden, May 12, 1891.
14. *British Medical Journal*, October 15, 1881; *Medical Reprints* for May 16, 1893; *Nineteenth Century*, December, 1895.

For one series of experiments in the above list, those made by Dr. Jansen upon children of the "Foundlings' Home," — with the "kind permission" of the head physician, Professor Medin, — because, as he said, "calves were so expensive," it appears that the only authority given was a reference to his lecture delivered before a Swedish medical society upon a certain date. Although, so far as known, the facts there stated have never been denied, yet the reference may, perhaps, be called indefinite. But *one* case is not "many." To what other of the references above given did you refer when you informed the Senate committee that "*many of them are so vague and indefinite that I could not look them up?*" Had you stated that your library — ample as it is — did not contain, and could not be expected to contain, all of the foreign authorities to which reference was made, there would have been nothing to criticize. I must assume, sir, that you have not put forth an aspersion of another's reliability merely to have acknowledgment of the inadequacy of your sources of reference; that the proofs of your statement, covering "*many*" cases, are available, and, in the interest of accuracy, I ask you to produce them.

Second: There is yet another point to which I ask your attention. You made the statement before the Senate committee that in regard to our published account of cases of human vivisection, "*many of them are so vague and indefinite that I could not look them up; but, as to those that I could, some are garbled and inaccurate; not all of them, observe.*"

This, sir, is a most serious charge. You distinctly declared that of the cases personally investigated by yourself, as quoted in the pamphlet on "Human Vivisection," some are "garbled and inaccurate." We deny the charge, and again challenge production of evidence upon which it is made.

A "garbled" quotation is one which, by reason of omission and perversions, is essentially unfair. Sometimes it is a statement from which parts are omitted or transposed for

the purpose of conveying a false impression. To omit quotation of parts not directly bearing upon the question for the sake of brevity — this is not "garbling," for all quotations would then be impossible. We assert that in quoting accounts of the cases of human vivisecton no omissions of essential facts have been made sufficient to impair the accuracy or fairness of the quotation. Let us put the matter to the test. Point out, if you can, the "some cases" which you found "garbled and inaccurate," and in proof of the charge *quote the omitted sentences or words which, had they been inserted, would cause you and the general public to justify and approve the experiments on human beings which we have so severely condemned.*

Third: You stated, sir, before the Senate committee that only two experiments upon human beings "are alleged to have been done in America." I question, sir, whether that remark is quite in accord with the highest ideals of truth; it is the language of doubt; it seems to signify and imply that even you are aware of no other experiments upon human beings than two cases which are thus "alleged." I am very confident, sir, that you will not venture formally to assert — what you have seemed to imply — that you know of but two experiments upon human beings made in this country and recorded in the medical literature of the United States. There is, indeed, need of further enlightenment if the medical profession of this country, so worthily represented by yourself, is ignorant of what has been done by men without pity and without conscience.

Trusting to have response from you at an early date, I am,

Yours most truly,

JAMES M. BROWN, *President.*

DR. KEEN'S REPLY

1729 CHESTNUT STREET,
PHILADELPHIA, PA., Jan. 21, 1901.

JAMES M. BROWN, ESQ., President American Humane Association, Toledo, Ohio.

DEAR SIR, — Your letter of October 4 reached me promptly, but as I then notified you would be the case, very pressing engagements, absence, etc., prevented an earlier reply. Now that I have a little leisure, I can answer your letter and furnish you in detail the proofs for which you ask.

There are two pamphlets, both entitled "Human Vivisection." First, one of thirty pages, "printed for the American Humane Association, 1899"; the other of seven pages, "published by the Humane Society, Washington, D.C.," without date, but from its contents published a little later, as it is chiefly a synopsis of the same instances reported more fully in the larger pamphlet. Hereafter, when I speak of "the pamphlet," I mean the larger one, unless I specifically mention the smaller one.

This larger pamphlet consists of two parts: first (pages 3–12), a reprint of a portion of Senate Document No. 78, and the rest of it of various quotations, translations, and comments. No name is attached to either part to indicate who is responsible for the accuracy of the references, the translations, or the quotations. As the whole is preceded by an open letter signed by the president and secretary of the American Humane Association, and as you refer to the pamphlet as "ours," I presume the association holds itself responsible for such accuracy, especially as you as its new president challenge me for proof.

The pamphlet purports to furnish a reprint of a portion of Senate Document No. 78 and refers to this document in a way that would lead uninformed readers to suppose that this is a document expressing the sentiments of the United States Senate. It is, therefore, important to call

your attention to the fact that Senate Document No. 78 is simply a collection of statements and papers by various persons, printed by order of the Senate, but in no sense expressing the opinions or convictions of that body. The last paper in Document No. 78 is one on "Human Vivisection," by "A. Tracy."

In two respects "A. Tracy" has a right to complain that the reprint is inaccurate: First, it omits to print the name of the author, "A. Tracy." [1] Surely he — or she(?) — should receive whatever credit there is attaching to his work. Secondly, on page 30, line 8, of Senate Document No. 78, I read, "A. Tracy's comment." ["This patient, therefore, was scientifically murdered."] This statement the reprint very wisely omits — but there are no indications of the omission. Of this, more hereafter.

Your letter challenges the accuracy of my statements in three particulars: (1) I stated that many of the references in the pamphlet are "vague and indefinite"; (2) I said that some of the accounts of the experiments are "garbled and inaccurate"; (3) I stated that of the experiments narrated in the pamphlet only two were alleged to have been performed in America.

You will pardon me if I indignantly resent your imputation of untruthfulness in regard to this last statement. You entirely misinterpret my statement, which had no reference to my knowledge or ignorance of any other American experiments. I said that the pamphlet only contained two instances of such experiments which were alleged to have been done in America. These are recorded on pages 4 and 5 of the pamphlet. All the rest were done in Europe, South

[1] In Watson's *Physicians and Surgeons of America*, Dr. Albert Leffingwell's full name is given as "Albert Tracy Leffingwell." In the same article it is noted that a book of his, "Rambles through Japan without a Guide," came out in London in 1892 under the pseudonym of "Albert Tracy." In the Catalogue of the Surgeon-General's Library Dr. Leffingwell's name is given as "Albert (Tracy) Leffingwell." In his own book on Vivisection his name is only "Albert Leffingwell." (1914.)

America, and Hawaii, years before it came into our possession. If you still question the accuracy of my statement and believe that there is a third instance of experiments done in America, and described in the pamphlet, point it out by page and paragraph.

Turning to the other two really important matters referred to in your letter, *let me again state clearly the question at issue. It is not whether the experiments meet with my approval, but solely whether the reports of them in the pamphlet issued by the American Humane Association are reliable and accurate both as to their sources and substance.*

1. *Many of the References are Vague and Indefinite*

The references are so vague and indefinite in many cases that the statements and quotations made cannot be verified by consulting the originals. The preface of your president and secretary states that "in *each case* the authority is given," and what sort of "authority" do you depend upon? Newspaper medicine and surgery are notoriously inaccurate. I have personally had so much experience and observation of this that I am always certain that at least one half or more of the statements in newspapers in reference to medical matters are inaccurate, not purposely, but only because the writers are not medical men. Yet you depend for the accuracy of your statements upon newspapers as follows (I follow the inaccurate spelling of foreign names in your pamphlet): —

1. The Vienna correspondent of the London *Morning Leader*, January 26, 1899 (p. 3), of whom more hereafter.

2. The *Deutsche Volksblatt*, January 25, 1899 (p. 3).

3. The Washington correspondent of the Boston *Transcript*, September 24, 1897 (p. 9), of whom more hereafter.

4. The New York *Independent*, December 12, 1895 (p. 11).

5. The London *Times*, June 27, 1891 (p. 16).

6. The *Tagliche Rundschau* of Berlin (p. 17); *no year, month, or day being given.*

7. The *Vossische Zeitung*, of Berlin, *no year, month, or day being given* (p. 18).

8. The *Vorwartz, no year, month, or day being given* (p. 18).
9. The *Danziger Zeitung*, July 23, 1891 (p. 18).
10. The *Schlesische Volkszeitung*, July 24, 1891 (p. 18).
11. The *Hamburger Nachrichten*, July, 1891, *no day stated* (p. 19).
12. A correspondent of the Newcastle (England?) *Daily Chronicle*, September 21, 1888 (p. 22).
13. Dr. R. E. Dudgeon, in the *Abolitionist*, April 15, 1899 (p. 24).
14. A letter by Dr. Edward Berdoe to the *London Chronicle, without year, month, or day* (p. 29).

Few of these fourteen newspaper references can be consulted in this country; five of them (numbers 6, 7, 8, 11, and 14) are impossible of consultation for want of any date whatever.

In no case would I be willing to admit a newspaper paragraph, a non-professional and usually unsigned statement, — even if correctly quoted, — as a sufficient authority for a grave charge against an individual or the profession.

Look for a moment what stuff Senator Gallinger stated at the "Hearing" he had himself caused to be printed. It is published on page 31 of the "Hearing" and on page 3 of the pamphlet. It consists of cable dispatches printed in some newspaper — Senator Gallinger did not even remember its name. The author of the dispatch from London is utterly unknown. The dispatch states that "the Vienna correspondent of the [London] 'Morning Leader' says" so and so. Who and how reliable is the Vienna correspondent? He says that "the physicians in the free hospitals of Vienna" do so and so. Who are the physicians? In what hospitals were these deeds of darkness done?

And upon such evidence it is seriously proposed to indict the medical profession! Whether these dispatches are "garbled and inaccurate" in their alleged facts, who can find out?

If a lawyer tried to convict a man of petty larceny on such testimony, he would be laughed out of court. And

yet a Senator of the United States and the American Humane Association actually adduce such statements as evidences of the gravest charges and spread them broadcast!

I now add six other "vague and indefinite" references not to newspapers.

15. On page 13 there is a quotation from Tertullian. The reference in the footnote is "Tertullian, *De Anima*, vol. II, pp. 430, 433, Tran. by Holmes." I have compared the quotation with Clark's Edinburgh edition of the Translation of Tertullian by Holmes, the date of the edition being 1870. No such quotation exists on pages 430–433. Possibly it may be that the quotation is from another edition. No edition is named in the pamphlet; another instance of a "vague and indefinite" reference.

16. On page 17 a formal accusation is quoted as made by a Dr. Eugen Leidig against certain surgeons. *No reference whatever to any book or journal is given* by which the accuracy of the quotation can be tested. Is not this again "vague and indefinite"?

17. On page 24 is a reference to a paper by "Professor E. Finger, of Vienna (*Allg. Wiener med. Zeitung*, nos. 50 and 51"). No year is given, a somewhat essential part of the reference, as there are over forty volumes of this journal, each with the weekly numbers 50 and 51. No such paper by Finger is published in that journal, at least from 1890 to the present time. The reference is quoted from a paper by Dr. R. E. Dudgeon in the "Abolitionist" — an English journal — of April 15, 1899. I have been unable to consult this journal. If Dudgeon gave the year, then the Humane Association pamphlet has misquoted him. If he did not, then both the association's pamphlet and he have been "vague and indefinite."

18. On page 25 again is a reference to a statement in a "lecture before the Medical Society of Stockholm," by Dr. Jansen, of the Charity Hospital, reporting certain experiments. No reference whatever is given even to a news-

paper, much less to any medical journal. As the statement is in quotation marks it purports to be the exact words used and ought to have had *some* source to which a reference was possible, especially as the preface of the pamphlet says: "In *each case* the authority is given." I am glad to see that in your letter you recognize this as one in which the reference *is* really inadequate. I notice, however, that even in your letter you do not supply this missing reference. You say the facts asserted in the Jansen paragraph have never been denied. Of course not. The first requisite is to know whether they are correctly quoted.

Turning now from the larger pamphlet to the smaller one, which was spread broadcast by house-to-house distribution in Washington at the time when the hearing on this matter took place last winter, I find repeated in this a number of the same vague and indefinite references and garbled and inaccurate quotations already or to be described, to which are to be added the following: —

19. On page 3, an extract from a report referring to experiments upon insane patients is printed in quotation marks. The only reference is to a "published report" in 1890 of the "Medical Staff of the Public Insane Asylum in Voralberg, Austria." The librarian of the Surgeon-General's office informs me that there are two small insane asylums in the Voralberg, namely, at Hall and Valduna. Some reports of the former are in the library, and in them no account of the experiments referred to can be found. No reply has been received to a letter addressed to this asylum as named in the pamphlet, and written over a year ago.[1]

20. On the same page is an account of some experiments on bacteria from boils, and the reference is to the "Deutsches Volksblatt"; *no day, no month, no number, no page, nor even the year* is given. If this is not "vague and indefinite," what is?

[1] This letter was written by myself and not by the librarian.

21. On page 24 there is an account of Kroenig's experiments, to which I shall recur later. No reference whatever is given to the source from which the account is taken.

2. Some of the Statements are Garbled and Inaccurate

To be vague and indefinite in charges affecting the morals and the reputation not only of individuals, but, in fact, of a whole profession is bad enough, but to make statements that are "garbled and inaccurate" is, as your letter recognizes, a much more serious matter. Let me consider the instances in detail.

1. "Vivisection Experiments upon the Insane," pages 4 and 5: In the following quotation, the words of the original, which I inclose in brackets, are omitted. "To these patients the thyroid tablets [each pill representing five grains of the fresh sheep's gland] were administered," etc. This omission is of moment, because any one familiar with the administration of thyroid extract knows that the doses used by Dr. Berkley are frequently given to human patients, including the insane, without producing symptoms dangerous to life, but, on the contrary, with benefit. I have myself given such tablets to patients with goiter for weeks together in larger doses than Dr. Berkley used.

In the following paragraph the quotation is garbled by omitting the words which I inclose in brackets: "Two patients became frenzied and of these one died before the excitement had subsided [the immediate cause of the exitus being an acute disseminated tuberculosis]." And again in the next paragraph giving a report of the same case, the pamphlet quotes: "The thyroid extract was now discontinued, but the excitement kept up . . . for seven weeks, at the end of which time she died." One would think this was the end of the sentence and that she died from the effects of the thyroid tablets. Not at all. The original continues as follows: She died "with the clinical evidences of acute miliary tuberculosis" — galloping consumption.

Does this not come within the definition of garbling given in your letter? "A 'garbled' quotation is one which, by reason of omission and perversions, is essentially unfair." To say that this patient, who actually died of galloping consumption, died from the effects of the thyroid extract, which had not been given for seven weeks before death, is as absurd as it would be to say she had died from the effects of moderate doses of laudanum given seven weeks before. Yet "A. Tracy's" comment on this case is: ["This patient was, therefore, scientifically murdered."] Your Association mutilates its reprints by wisely omitting this piece of absurdity, though the omission is not indicated. Moreover, the pamphlet states: "There is no intimation that the administration of the poisonous substance was given for any beneficial purpose to the patients, for he took care to select patients that were probably incurable." On the contrary, Berkley's original paper expressly states that instead of being incurable, one (case 1) was cured and another (number 3) was improved. Besides this, though the pamphlet is dated 1899, it omits all reference to Dr. Berkley's letter to the "British Medical Journal" for October 30, 1897, in reply to your friend Dr. Berdoe, which shows that, as a result of the administration of the thyroid tablets to these eight patients — a well-recognized remedy for insanity,[1] *not one* died from the effects of the drug, but that, on the contrary, two of those alleged "incurables" were *cured* — twenty-five per cent.

In his admirable letter to "Life," — December 6, 1900, — Dr. Berkley says: "The purpose for which the article was written was to show to the medical profession that *a*

[1] I quote the following from the eighth edition of Hare's *Therapeutics*, as to the use of thyroid extract: "In the dose of from five to twenty grains (0.35–1.3) three times a day [i.e., fifteen to sixty grains a day] according to the degree to which it produces its effects, it has proved of value in acute mania and melancholia, puerperal and climacteric insanities, and in stuporous states with primary dementia." Berkley's maximum dose was fifteen grains a day.

certain medicament in common use was not free from objection, and should not be given in unsuitable cases. In proper ones the results are among the most resplendent attained by modern medicine, converting the drooling dwarf into an intelligent, well-grown man or woman; or in other instances, as in myxedematous insanity, affording the otherwise hopelessly insane with almost a specific to recover their reason." (See the addendum at the end of this letter.)

2. The "Cases of Lumbar Puncture," by Dr. Wentworth, of Boston (p. 5): [1] "Lumbar puncture," I may remind you, is the simple insertion of a hypodermic needle between the vertebræ into the sheath of the spinal cord, but below the cord itself, to obtain a few drops of the cerebro-spinal fluid for diagnosis.

The pamphlet gives what is called a "brief abstract" of five of the experiments related. The abstracts are indeed brief, so brief as to give a wholly erroneous impression as to the causes of the patients' death. The omissions are glaring instances of what the logicians call a *suppressio veri* equivalent to a *suggestio falsi*. Let me point this out in detail.

Case 2. It is correctly quoted that the last puncture (where there were several punctures I only give the last date) was made "February 16, on the day of the patient's death." The pamphlet fails to add, however, the important fact stated by Dr. Wentworth that the *post-mortem* showed an empyema [abscess in the chest] which had burst into the lung, pneumonia, and inflammation of the brain with pus as the causes of death.

Case 3. The pamphlet correctly says: "Puncture January 17, 1896; patient died January 22." What Dr. Wentworth adds is omitted, namely: "No symptoms attended or followed the operation." Moreover, the *post-mortem*

[1] For a further discussion of the cases of Dr. Wentworth, due to later and still worse misstatements, see "The Influence of Antivivisection on Character," *post*, pp. 274–278.

showed that the patient died from the widespread changes common to infantile wasting.

Case 5. The pamphlet says: "Puncture February 3, 1896; patient died February 4." It omits to state what immediately afterward follows, that the *post-mortem* showed "primary tuberculosis of the intestines. Double pneumonia," as the causes of death.

Case 6. The pamphlet quotes: "Puncture February 1; patient died in convulsions three weeks later." It neglects to state what Dr. Wentworth particularly mentions, "no reaction on the part of the patient attended the operation," and it also fails to state that the child was seen only once, and that the diagnosis then made was tuberculous meningitis, which was clearly the cause of the child's death, three weeks later.

Case 7. The pamphlet quotes: "Punctured February 27; patient died February 28." It omits the fact that the *post-mortem* showed that the child died from defective development of the brain and other causes; and that the history showed that the child, who was seven months of age, had "frequent convulsions, which began when he was about three months old. While in the hospital the convulsions occurred not less than twenty times a day. Oftentimes he had several in an hour."

The inference from the pamphlet's "brief abstracts" of these cases is clearly, and it seems to me by these omissions was meant to be, that the deaths were due to the lumbar punctures, whereas the evidence is that the deaths were due to other causes, and in two instances the operation is expressly stated *not* to have done any harm. Are not these abstracts "garbled and inaccurate"?

3. On page 7 the pamphlet refers to some experiments on the inoculation of lepers with syphilis, made in Hawaii, but published in the "New York Medical Record" of September 10, 1892. It is stated that the patients "were already suffering from one incurable disease and the object of the

experiment was to ascertain whether with another, and even worse, disorder, they might not be infected." This statement is incorrect. Most writers recognize only three stages of syphilis, primary, secondary, and tertiary. The writer of the article in question believed that leprosy was a fourth and final stage of syphilis and not an independent disease. It is a well-recognized fact by all scientific writers that a patient suffering from syphilis in any stage is immune to an inoculation of the virus; that is to say, the inoculation will not "take" if he is already a syphilitic. It was for the purpose of determining whether leprosy was a fourth stage of syphilis that the attempt was made. *None of those inoculated took the disease.*

4. Sanarelli's "Experiments on the Inoculation of Yellow Fever," page 8: The references here are to the "British Medical Journal" for July 3, 1897, and the "New England Medical Monthly," March, 1898. The extracts marked with quotation marks are from the "New England Medical Monthly." Between the first and the second sentences of the quotation there should be some stars to note an omission, but none such appear. The omitted words state that *not* the germs of the disease, but the carefully filtered and sterilized germ-free fluid was used. Besides this and many other minor inaccuracies many of the scientific terms are changed into non-medical terms, which is not objectionable in itself. But such changes and inaccuracies should exclude quotation marks, for when used they mean that the words quoted are the *ipsissima verba* of the author, if in the same language, or an exact translation if from a foreign language.

But this is the least of all. The pamphlet says that the injection produced certain symptoms, among which are mentioned "the jaundice, the delirium, *the final collapse*," the last three words being in italics in the pamphlet to call special attention to them. In the "British Medical Journal," and in the "New England Medical Monthly" the

words "the final" *are not to be found.* We see not a few patients suffering from "jaundice, delirium, and collapse" who recover, but when the expression is changed to "the final" collapse, it means to every one that the patient died.

Moreover, the end of the quotation is as follows: "I have seen [the symptoms of yellow fever] unrolled before my eyes thanks to the potent influence of the yellow fever poison made in my laboratory." *This entire sentence does not occur* either in the "British Medical Journal" or in the "New England Medical Monthly." Whether it is quoted from some other source not indicated, or has been deliberately added, I leave you or "A. Tracy" to explain.

Moreover, immediately afterward, on the authority of the Washington correspondent of the Boston "Transcript," it is stated: "It is understood that some, if not all, of the persons inoculated died of the disease"; and then seven times afterward are repeated "the final collapse," the "unrolling before the eyes," "scientific assassination," "death," and "murder," quoted from a public speech before the American Humane Association. Let us see if these *were* "murders."

In the two references given there is no indication whether any of these patients died or not. How, therefore, "it is understood that some, if not all, of them died," I do not know. *As a matter of fact none of the human beings inoculated by Sanarelli died,* as any one desirous of learning the truth could have ascertained by consulting Sanarelli's original publication reporting his experiments with full details.[1]

What hysterical oratory about "the final collapse," which was not final; "scientific assassination," which did not assassinate; and "murder" of those who were so disobliging as still to live! And this on the authority of the Washington correspondent of the Boston "Transcript,"

[1] *Annali d'Igiene Sperimentale,* 1897, vol. VII, Fascic: III, pp. 345 and 433.

who, the pamphlet assures us, is a person "who would seem to be unusually well informed in matters of science"! An excellent example of "newspaper medicine" and a good reason for my refusal to accept it as evidence, especially from other correspondents who may not be as "unusually well informed." May I ask whether "the Vienna correspondent of the London 'Morning Leader'" is also one of those who, in your opinion, is "unusually well informed in matters of science," and whether his testimony is as wholly false as the one under consideration?

5. On page 23, the pamphlet quotes an account of some experiments of Dr. Neisser from the "Medical Press and Circular [England], of March 29, 1899." This is an instance again of misquotation and omission which can scarcely be other than intentional. The last sentence of the first quotation states: "Of these eight girls, four developed syphilis." No stars indicate that any words have been omitted. The original reads: "Of these eight girls [five were prostitutes, and of these five] four developed syphilis." The words in brackets are entirely omitted in the pamphlet. They make a deal of difference, for what is more probable than that four out of five prostitutes should develop syphilis? Whether it makes any difference or not, however, is at present not the question. The issue is whether the quotation is "garbled and inaccurate." Does it not fulfill another of the definitions of "garbling" given in your letter, namely, "omissions of essential facts . . . sufficient to impair the accuracy or fairness of the quotation"?

Moreover, the pamphlet's comment upon this case is as follows:—

"Does the London journal which reports these awful experiments denounce them as a crime against every law of morality? Not at all. It simply says that 'it would be difficult to acquit Dr. Neisser of a large measure of responsibility in respect of the causation of syphilis in these cases'! Could reproof be more gentle?"

Is that really all that the "Medical Press and Circular" "simply says"? On turning to that journal, after the above sentence, which is correctly quoted, the editorial continues thus: "We, however, are less concerned in establishing the culpability of Dr. Neisser than in condemning the spirit which prompted such experiments. All measures, even if novel, which may reasonably be expected to assist in bringing about the recovery of the patient without injury to his health may legitimately be resorted to with the consent of the patient, but measures, whether by drugs or by operation, which have not for direct object the cure of the patient and which may prove inimical to his health or condition, are inadmissible under any circumstances and must expose the perpetrator to professional ostracism and to penal rebuke."

Is "professional ostracism and penal rebuke" a reproof than which nothing could be "more gentle"? If this statement is not "garbled and inaccurate," what do words mean? How could this misrepresentation be otherwise than intentional?

6. On page 24 again, reference is made to the experiments of Menge.[1] The extracts being in quotation marks would purport to be exact translations. This is not the case. The collocation of the paragraphs, also, — especially in the smaller pamphlet, — is such that it would be supposed even by a careful reader that the babies experimented upon were inoculated with the germs taken "from the pus in the abdominal cavity of a person who had died of peritonitis," without any precautions or preliminary experiments, and that, therefore, these babies were exposed to a fatal infection. This is not true. Four columns of text in the original intervene between the first and the second paragraphs alleged to be quoted, and these detail experiments which proved that the inoculations which he then carried out would almost certainly be harmless. The result showed

[1] *Deutsche medicinische Wochenschrift*,, 1894, nos. 46 to 48.

that he was right, for not the slightest ill effects followed. I have only words of condemnation for Menge's experiments, but to misrepresent these experiments is scarcely less culpable than to perform them.

7. Then follows a brief account of Kroenig's experiments. The objects of these, the pamphlet says, were "to observe the surest way of *breeding* purulent bacteria." This is not true. On the contrary, his object, like Menge's, was to determine how these bacteria are normally *destroyed* in the part of the body in which the experiments were made. In only a single instance did any ill effects follow, and in this case the inflammation was brief and not dangerous either to life or health. In fact, the very *titles* of these two papers proclaim the destruction of the bacteria and not the surest way of breeding them. Menge's title reads: "On a quality (*Verhalten*) of the vaginal secretion in non-pregnant females, which is *hostile* to bacteria"; and Kroenig's is on the same peculiarity in pregnant women.

In the comment on these two series of experiments, they are spoken of as inoculations "with loathsome diseases," which would suggest to any one that the patients were successfully inoculated with syphilis or other similar diseases. This was not the case. Only inflammation would follow even had the inoculations been successful.

Moreover, to show the vague looseness of the alleged quotations, the two paragraphs on the experiments of Menge are in quotation marks and are introduced by the words, "He says: The bacteria I used," etc., as if they were exact continuous translations. "He says" nothing of the kind. Instead of being exact translations, the first paragraph is made up of partly correct and partly incorrect translations from page 891, near the top of the second column and near its middle; and the second paragraph of partly correct and partly incorrect translations from page 907, near the bottom of the first column.

No reference whatever is given to Kroenig's paper either

by number, date, or page. Is not this "vague and indefinite"? As a matter of fact, it is the same journal (no. 43, p. 819) as Menge's paper, but published three weeks earlier.

8. On page 25 is one of the most outrageous instances of garbling, and mistranslation, or worse, which I have ever known to be perpetrated, even in antivivisectionist publications. It relates to observations and experiments of Professor Schreiber, reported in the "Deutsche medicinische Wochenschrift" of February 19, 1891. The subject is introduced with the startling caption: "Inoculations with Tuberculin and Germs of Consumption." In the smaller pamphlet the caption is simply: "Injected Germs of Consumption." What was injected was *not* the "germs of consumption" at all, but tuberculin, a substance which at the date of Professor Schreiber's publication was engaging the attention of physicians throughout the civilized world as a therapeutic and diagnostic agent. To describe inoculations with tuberculin as "inoculations with the germs of consumption" can be attributed only either to gross ignorance or to willful disregard of the truth.

In the first paragraph occurs the sentence: "He began with one decimilligram and continued to inject the tuberculin in ever-increasing quantities, until he at last injected as much as five centigrams, about fifty times as much as Koch said was the maximum dose for children of three to five years old." Any fair presentation of these experiments would have included Professor Schreiber's sentence, which he prints in bold-face type: "But even with so large a dose injected at one time, the children showed *no trace of a reaction.*" It would, perhaps, be too much to expect your society to have indicated on what grounds Professor Schreiber was led to the employment of such large doses, and that his observations demonstrated for young infants an exceptional tolerance of tuberculin, a phenomenon for which there are analogies with other drugs.

But the worst falsification is the succeeding account, in the form of what purports to be an exact translation of Schreiber's inoculation of a boy with tuberculin. The alleged quotation begins: "I am sorry to say that it is very difficult to obtain subjects for such experiments. There are, of course, plenty of healthy children in consumptive families, but the parents are not always willing to give them up." The words, "I am sorry to say that," and the entire next sentence, "There are, of course, plenty of healthy children," etc., *are not in the original, but are additions made out of the whole cloth.* The next following sentences contain many inaccuracies, such as the translation of the German words *beträchtlich anschwollen* as "swelled up enormously," instead of "swelled up considerably." But the worst is the deliberate insertion of the following sentence, italicized in the pamphlet, *which also does not occur in the original:* "I cannot yet say whether the boy will be consumptive in consequence of my treatment." The correct translation of Schreiber's words at the point where this closing sentence appears in the pamphlet is as follows: "I could discover no other alterations in the otherwise apparently healthy boy." ["*Andere Veränderungen konnte ich an dem sonst gesund scheinenden Knaben nicht entdecken.*"]

While I have said enough about this case to substantiate my charge of garbling and inaccuracy, I cannot refrain from utilizing it also to show the utter misapprehension which the citation of detached sentences and paragraphs from medical articles is calculated to create in the mind of a non-medical reader. Even when the words are quoted correctly, they are likely, when detached from the context, to give rise to entirely false impressions. This is a criticism which applies not only to other examples cited in this pamphlet, but to a very large number of reports of experiments and of quotations from medical journals and books current in antivivisectionist writings, and the resulting dissemination of erroneous conceptions is often greater even than that

caused by inaccurate or garbled quotations. A brief explanation of the present example will show the justification of this charge.

For what purpose did Professor Schreiber inoculate the boy with tuberculin? His article leaves no doubt as to the answer. He points out the importance of the earliest possible recognition of tuberculosis in a patient in order to secure the best curative results. The boy's mother had consumption and the author calls attention to the frequency of unrecognized tuberculosis in the offspring of tuberculous parents. The boy received a small dose — one milligram — of tuberculin, which, if he were free from tuberculosis, would produce no effect, but which, if he had unsuspected tuberculosis, would produce a transient — though possibly a severe — fever, and a local reaction indicative of tuberculosis. Such reaction followed the injection of tuberculin, and the diagnosis of tuberculosis, which had not been, and very likely could not have been made in any other way, was established. I do not know what could have been more fortunate for this boy than the recognition in its incipiency of a disease previously unsuspected and which, recognized thus early, should in all probability be cured by proper treatment. This tuberculin test is constantly employed to prevent the spread of tuberculosis in our cattle. In our children it enables us to discover the same disease in an early, curable stage. Shall we care for our cattle better than for our children?

The use of tuberculin is not properly to be called an "experiment" at all. As I write this, I find in the "Journal of the American Medical Association" for January 12, 1901 (p. 75), three cases of the use of tuberculin in human beings by Professor J. M. Anders, who points out its value in enabling us to diagnosticate consumption "in latent forms and dubious cases, however incipient," long before percussion or the stethoscope will reveal the disease. I can imagine his surprise if he were charged with making

three horribly cruel "experiments" and injecting the "germs of consumption"!

It is a euphemism to call such an alleged quotation, in which words and one entire sentence are interpolated and another wholly changed in meaning, a "mistranslation" or even a "garbled and inaccurate" account. Does it not amount to literary forgery? It is another illustration of the fact that when an antivivisectionist attempts to say anything about scientific experiments either the moral sense is blunted or the truth-telling faculty is in abeyance. A good English example are the misstatements in Miss Frances Power Cobbe's book, laid bare by Victor Horsley, and Schreiber's and Sanarelli's cases will serve as excellent examples of American misrepresentation — if so long a word is needed to describe them.

I am sorry my reply is so long, but in fewer words I could not explain the many and gross errors to be pointed out. I have given you, indeed, "many" instances in which the references are "vague and inaccurate," and "some" in which the accounts are "garbled and inaccurate." These adjectives are, I submit, very mild ones to apply to such a pamphlet.

You can hardly be surprised, after the extraordinary and repeated interpolations, mistranslations, and worse which I have demonstrated in this letter, that I am unwilling to accept *any* alleged quotation or translation emanating from the American Humane Association as accurate and truthful unless I can compare it with the source from which it is derived.

In conclusion, let me commend to the "Humane" Association the closing words of President Eliot's letter, to be found on pages 218–19 of the "Hearing": "Any attempt to interfere with the necessary processes of medical investigation is, in my judgment, in the highest degree inexpedient and is fundamentally inhuman."

I shall take the liberty of publishing my reply. I suppose

that you will not object to the publication of your letter with it in order to explain the reason for the reply.

Very respectfully yours,

WILLIAM W. KEEN.

Addendum

Since this letter was written I have seen an article in "Gould's Year-Book of Medicine and Surgery," 1901 (Medical volume, p. 327), from the "Archives of Pediatrics" for June, 1900 (p. 431), by H. Oliphant Nicholson, of Edinburgh, Scotland, reporting the case of Annie C., a girl of two years and eight months old, with pictures, which, with a brief statement of the case, well illustrates what Dr. Berkley has asserted, that "in proper cases, the results [of the treatment by thyroid extract] are among the most resplendent attained by modern medicine, converting the drooling dwarf into an intelligent, well-grown man or woman."

This child was first seen by Dr. Nicholson on October 23, 1894, and the picture shows the "swollen, myxedematous-looking face and body, a markedly curved back, and a pendulous abdomen." The child "could not walk without support and dragged her limbs slowly after her." Her vocabulary was confined to calling her mother and father "mum" and "ah," and "her wishes were wholly made evident by signs." Very naturally, therefore, with this low grade of intelligence, she was uncleanly in her habits.

The treatment was begun on October 30, with 2.5 grains of thyroid powder, once daily. This was reduced on November 2 to 1.25 grains once a day, and was continued for several weeks. As early as November 7, improvement was noticed. On November 17 the pulse at the wrist, which was scarcely perceptible through the swollen tissues at the beginning of the treatment, was distinctly felt, and by the 24th, the puffiness of the eyelids and forehead were dimin-

ishing and the expression of the face becoming more intelligent. The dose of the extract was now increased again to 2.5 grains. The results I quote as follows: —

> In about three months' time very few traces of cretinism remained and the child was able to walk about easily without assistance and was making use of the short words and gestures of early childhood. . . . After four months of the thyroid treatment, the improvement seemed so complete that the second photograph was taken and the likeness produced is that of a bright, happy, pretty child, to all appearances normal, both physically and mentally. The improvement continued till the middle of June, 1895, when, unfortunately, she contracted an attack of malignant measles and died on July 16, after three days' illness.

If Dr. Berkley's use of the thyroid extract, which cured two out of eight patients was an experiment, and its administration by Dr. Nicholson also was an experiment, the more of such happy "experiments" we could have the better.

P.S. (1914). At the recent Antivivisection Congress in Washington, Mr. E. H. Clement, of Boston, stated categorically (according to the Washington "Post," December 9, 1913), that "Three of the most prominent physicians in Boston — Drs. J. Collins Warren, Richard C. Cabot, and Maurice H. Richardson — have assured me personally that they do not believe in vivisection."

Now I knew the late Dr. Richardson personally and intimately ever since 1886, and I know positively that this was not his opinion, and both Dr. Warren and Dr. Cabot assure me that it is not their opinion.

MISSTATEMENTS OF THE ANTIVIVISECTIONISTS AGAIN [1]

San Francisco, July 8, 1901.

On January 21, 1901, I sent a reply to James M. Brown, president of the American Humane Association, in response to a letter from him challenging me to produce proof of inaccuracy in the references to a number of certain alleged experiments and of garbling of the reports of the same.[2] My reply was published in "The Journal of the American Medical Association" and the Philadelphia "Medical Journal" of February 23, 1901.

In reply I received a letter from Mr. Brown saying that he expected to spend the month of February in California, and could not give attention to my letter until his return.

Mr. Brown seems to have been detained in California much longer than expected, for up to the present moment — nearly six months — I have received no further reply whatever from him. Indirectly, however, a certain reply has been published in the form of an anonymous pamphlet entitled "The Reality of Human Vivisection," which is called a "review" of my letter.

Not long since I had the pleasure of attending a lecture to one of his classes in moral science by Rev. Dr. Faunce, the accomplished president of Brown University. Among the virtues which he discussed was "Courage," and he pointed out the moral cowardice of anonymous letters. While such a letter is an instance of private moral cowardice, an anonymous pamphlet such as this is an instance of public moral cowardice. An honorable open foe I at least respect; one

[1] Reprinted by permission from the *Journal of the American Medical Association* for August 16, 1901.

[2] *Ante*, p. 110.

who skulks behind anonymous pamphlets I despise. The antivivisectionists seem to delight in such secrecy and anonymous attack.

There are four publications on this subject up to the present moment, to which I shall hereafter refer by number, except the last, which I shall call the "review."

1. In Senate Document No. 78, 55th Congress, 3d Session, the last of a collection of certain antivivisectionist papers is one entitled "Human Vivisection," signed "A. Tracy." I should like to know who this mysterious "A. Tracy" is.[1]

2. There is a pamphlet entitled "Human Vivisection," third edition, printed for the American Humane Association in 1900, which reprints this paper (with the omission of "A. Tracy's" name) and adds to it a long continuation of the misstatements of the first. This is anonymous.

3. There is a small pamphlet entitled "Human Vivisection," published by the Humane Society, Washington, D.C., chiefly a rehash of the misstatements of pamphlet No. 2. This is also without the name of any author.

4. Now comes the last pamphlet, the "review" of my letter. This is not only without the name of any author, but without even that of a publisher. It is simply dated "Boston, 1901."

The character of every one of these publications, however, is such that I do not wonder that the author wishes to conceal his identity.

The "review" (No. 4) reprints Mr. Brown's letter to me, and at the end adds: "No sufficient rejoinder to his [my] letter [in reply to Mr. Brown] would be admitted to the columns of these medical periodicals" ("The Journal of the American Medical Association" and the Philadelphia "Medical Journal"). The duplicity of this sentence is evident. The ordinary reader, for whom it is evidently intended, would understand that a reply had been sent to the

[1] See footnote, *ante*, p. 115.

editors of these medical journals and that they had declined to print it. This is absolutely untrue. No such communication has ever been received by the editor of either of these journals. The critical reader will see that the sentence just quoted does not definitely state that such a communication has been rejected. But for one critical reader a thousand casual readers will get the impression which the sentence was evidently intended to convey.

It is impossible for me to take up all the misstatements and misrepresentations contained in the thirty-two pages of this last anonymous "review," nor is it necessary to do so. That I should be honored from such a source by vilification and misrepresentation, I expected, of course, but I did hope at least that there would be an honesty of statement to which no exception could be taken.

The author, however, is a very curious person who does not seem to be limited by the ordinary laws of either fair dealing or truthful statement.

Moreover, he would be a very poor lawyer. Most of the evidence cited by him is derived from published reports by certain medical men. Having, therefore, chosen his witnesses and put them on the stand, he would not be allowed in any court of law to discredit his own witnesses by selecting part of their testimony as trustworthy and rejecting part as unworthy of credence. And yet, throughout this "review," while the anonymous author is eager to accept the statements of the various authorities as to what they *did*, he declines to admit their statements as to their *results*, or else misstates them, going so far as to assert that the statements of the physicians cited, concerning the recovery of their patients, are "utterly valueless."

In my reply to Mr. Brown, I used the following language: "Let me again state clearly the question at issue. *It is not whether the experiments meet with my approval*, but solely whether the reports of them in the pamphlet issued by the American Humane Association are reliable and accurate

both as to their sources and substance." At the hearing before the Senate committee, I distinctly twice over expressed *my utter disapproval* of many of the experiments referred to in the original pamphlet (No. 2). This condemnation is quoted both on page 1 and page 5 of the anonymous "review"; yet, in spite of these two statements and the third in my letter to Mr. Brown, just quoted, the author represents me throughout his "review" as the apologizer and the advocate of such experiments, thus publishing, yet at the same time willfully ignoring, my repeated statements to the contrary.

In my letter to Mr. Brown, in support of my accusation that many of the references in the pamphlet on "Human Vivisection" are "vague and indefinite," I cited fourteen instances of quotations from newspapers, five of which were without date, and I added six other instances of "vague and indefinite" references not to newspapers. I commented upon the unreliability of newspapers as a source of authority in medical matters.

Let us see how the anonymous reviewer attempts to meet this issue. The facts he does not and cannot deny. In the first place, he claims that I have changed the issue from "the question of 'vague and indefinite quotation' to that of vague and indefinite '*references.*'" When I stated at the Senate hearing (stenographer's report), "Many of them are so vague and indefinite that I could not look them up," it must have been clear to any one of common sense that I referred to the references to the experiments, and there was no misunderstanding on this point in the letter of Mr. Brown, who asks, "To what other of the references above given did you refer when you informed the Senate committee that '*many of them were so vague and indefinite that I could not look them up*'?" I was challenged by Mr. Brown to adduce examples of "vague and indefinite references," and this challenge I successfully met.

On page 22, the anonymous reviewer says: "Of the four-

teen journals referred to, *every one* conveying a statement of fact — save one — had its name and date of publication plainly given." Here it will be observed that a distinction is drawn between references to articles "conveying a statement of fact," and those which do not relate to statements of fact. My indictment against the pamphlet on "Human Vivisection" (No. 2) was and is that many of the references are so "vague and indefinite" that the original sources of alleged quotations cannot be consulted, and that some of the reports are "garbled and inaccurate." It may be just as important to determine the accuracy of a reference to an expression of an opinion as to learn the facts upon which the opinion is supposed to be based, and to charge me with an evasion of the issue because I did not restrict myself solely to one particular class of references, but pointed out the vague and indefinite character of all classes of references in the pamphlet, is too absurd to require further comment.

As a matter of fact, as pointed out in my letter to Mr. Brown, there are no less than five citations or reports of experiments in pamphlet No. 2 for which either no reference whatever is given, or the one inserted is wrong or so vague and indefinite that the original cannot be consulted.

On page 9, the anonymous reviewer says: "It was pointed out by the president of the American Humane Association that, with one exception, every phase of experimentation specifically mentioned had some reference to a medical authority." It is incredible that the reviewer should not have known the falsity of the statement attributed by him to the president of the American Humane Association, or he may think that in this strangely worded sentence he has constructed some loophole of escape through such avenues as may be afforded by throwing the responsibility for a false statement upon another, or by such equivocal phrases as "every phase of experimentation," "specifically mentioned," "some reference." There

are, in fact, in the pamphlet of the American Humane Association seven instances in which reference to a medical authority for the experiments mentioned is lacking, and in addition the sole authority for an important part of the statements regarding Sanarelli's experiments are the correspondent of a daily newspaper and a speaker at a convention of the American Humane Association.

Let us see how the reviewer tries to meet my demonstration of numerous instances of "garbled and inaccurate" quotations in pamphlet No. 2. Here again the facts cannot be denied, but an attempt is made to minimize their importance.

1. "Brevity of quotation is often absolutely necessary" ("review," p. 9). Why, then, as I pointed out in my letter, are whole sentences *added* which do not appear at all in the original?

2. Errors are described in the "review" as a "translator's exaggeration" (p. 6), "blunders of a copyist" (p. 6), "errors of a translator" (p. 7). So, then, it is now conceded that the pamphlet does contain "exaggerations," "blunders," and "errors." It contains not merely "errors of a translator," but deliberate falsification and misrepresentations. When a translator says what the author did *not* say; when the word "collapse" is translated "final collapse," and an oration is made upon the death of patients who did not die; when the American Humane Association in reference to these very cases quotes on the cover of its pamphlet, "Is scientific murder a pardonable crime?" in spite of the published fact that the patients referred to did not die; when the translator again and again interpolates words, phrases, and sentences which do not exist in the original; when essential phrases and paragraphs are omitted, — these I submit are not the mere "errors of a translator," but deliberate misrepresentations. Instances of all of these I furnished Mr. Brown in reply to his challenge.

The pamphlet, moreover, contains, as I have pointed

out, false or misleading quotations which could not be attributed to "errors of a translator," as they were from English sources. One can only hope that hereafter the "translators" and "copyists" employed by the antivivisectionists may be more accurate, or rather that the men and women back of these poor employees may be willing not to distort and suppress the truth in order to effect their purpose. It is a safe rule, I repeat, not to believe any statement of an antivivisectionist until its accuracy is established by reference to the original source from which the alleged statement or quotation is derived.

3. My charge of garbling and inaccuracy of quotation is practically admitted, but the reviewer states (p. 15): "For none of them [the translations] was the American Humane Association responsible in any way whatever." It is now rather late in the day to advance this disclaimer, after the insertion on the inside of the cover of the pamphlet of the sentence, "The facts are indisputable," and in the preface, over the signature of the president and secretary of the Association, the words, "In each case, the authority is given." It is a favorite trick of antivivisectionists to attempt to throw off in this way responsibility when confronted with incontrovertible evidence of false statements, as is illustrated in the controversy between Miss Cobbe and Mr. Horsley.

I shall be curious to see the fourth edition of this pamphlet. For it I now furnish one more instance of false statement, the evidence of which was not in my possession last January. Even Mr. Brown admits that to this "the reference may, perhaps, be called indefinite." I submit that "perhaps" it may, for no book, journal, or any other publication was named. The instance I refer to is Jansen's lecture purporting to be quoted on page 26 of pamphlet No. 2. The lecture was published, I have since found, in a well-known journal, the "Centralblatt f. Bakteriologie u. Parasitenkunde" (1891, vol. x, p. 40). So gross is the falsifica-

tion that the reference was "perhaps" wisely omitted. The first phrase of the quotation is as follows, "When I began my experiments with smallpox pus," etc. This is an absolute untruth. What Jansen used was not smallpox pus at all, but sterilized, diluted vaccine lymph, and sterilized blood serum from vaccinated calves, which could do no more harm than injecting so much water. The entire extract is inaccurate as a translation. There can be no question but that the substitution in this alleged quotation of "smallpox pus" for "sterilized vaccine lymph" cannot be attributed to the mere "error of a translator," but is a deliberate falsification, and this in a pamphlet introduced with the statement to the reader, "The facts are indisputable"!

Much has been made of my statement that I could only find in the pamphlet references to "two experiments" in America. My reason for this statement was very simple and perfectly evident to any honest-minded reader.

In the pamphlet "Human Vivisection" (No. 2) there are a number of experiments related, the numbered ones beginning with the following on page 4: "1. Vivisection Experiments upon the Insane." Under this title several experiments, all of the same nature and by the same individual, are reported, eight being referred to in all. On page 5, appears, "2. Vivisection of Children in Boston"; and under this a number of experiments, all by the same person, are referred to. Anybody with common sense would see that when I referred to "two" instances, I did not mean two individual experiments, but using the classification of their own pamphlet, I referred to Nos. "1" and "2" on pages 4 and 5. In fact, I specifically referred to these pages and mentioned various experiments under each caption.

I presume, however, that it is useless to expect fairness from an ambushed enemy.

The anonymous "reviewer's" suggestion that as I was president of the American Medical Association last year,

therefore I am responsible for every paper read before that body, — when there were hundreds of papers read in over a dozen sections before several thousand members, — is so amusing that I pass it by with a smile at the author's simplicity.

One sentence of my letter I wrote perhaps better than I knew. In the account of Sanarelli's experiments a certain sentence, "I have seen unrolled before my eyes," etc. was quoted by "A. Tracy" in the original paper (No. 1). In that pamphlet two references were given, one to the "British Medical Journal," the other to the "New England Medical Monthly." I stated that this entire sentence occurred in neither of these journals and I added: "Whether it is quoted from some *other source not indicated* or has been deliberately added, I leave you or A. Tracy to explain." The "reviewer" explains that this quotation *was* from another source not indicated (surely this was "vague and indefinite"), namely, Sanarelli's original Italian paper, though no reference to it was given.

Inasmuch as in my letter to Mr. Brown I gave the reference to Sanarelli's original paper, the anonymous author of the "review" pays me the compliment of supposing that I am a facile Italian scholar, and, therefore, that I was perfectly aware that Sanarelli himself wrote this sentence. "With the volume in his hands, the original article open before his eyes," says the "reviewer," "would he have us believe that he did not take the trouble to compare and verify the only quotation from it which appears in the pamphlet? He did not see it? Credat Judæus Apella! There are limitations to credulity. But how queer must be that sense of honor which would permit a man to make a disgraceful imputation knowing all the while that every word of it was false!"

The simple facts of the case are these. Unfortunately, I am not an Italian scholar, and have *never even seen* Sanarelli's original article. In order to find out the *real* fact, I

wrote to a friend who reads Italian well, to learn whether these five patients really died, as the American Humane Association pamphlet (No. 2) asserted. He replied giving me the original reference, and stated that not one of them died.

As the "reviewer" points out that this quotation by "A. Tracy" was from Sanarelli's original paper, a very interesting inquiry arises, namely, if "A. Tracy" in Senate Document No. 78, as is now claimed, quoted from this original paper of Sanarelli, it is in order for him now to explain how it is, when Sanarelli's original paper states that all of these patients recovered, that he states that *some, if not all of them died*, and how he dares to quote nearly a page of oratory about "scientific murder" and "assassination," based upon this false statement.

On page 26 of the anonymous "review" the author disputes the value of tuberculin as a test for incipient consumption in children. Were it worth my while I could give him references to disprove this statement, but in view of his amazing ignorance of modern medical progress, as evinced by the next statement, I do not propose to take the trouble. He says, "Dr. Keen knows perfectly well, in the first place, *that phthisis, however early discovered, is not in all probability a curable ailment.*" Has he never made a *post-mortem* examination and found a cured phthisis? Has he never visited, or even read of, the Adirondacks, or Denver, or Colorado Springs, or Minnesota, or Arizona, or New Mexico, or a score of other such places? Has he never read of the many books and pamphlets on sanatoria for consumptives? Does he know nothing of these modern movements? Koch's discovery of the bacillus of tuberculosis by experiment upon animals in 1882 has done more to help in curing consumption and other forms of tuberculosis than any other one means and especially by early recognition of the disease. If he will consult the recent prize essay on "Tuberculosis as a Disease of the Masses and how to Com-

bat it," by Dr. S. A. Knopf, of New York, he will be made aware of the facts. This essay was awarded the prize by the International Tuberculosis Congress last year in Berlin in a competition in which eighty-five prize essays were presented from all over the world.

When I see the statement that phthisis is not curable even when discovered at an early stage, put forth seriously by my anonymous reviewer, I throw down the pamphlet in despair. One cannot argue further with such dense ignorance. It is equal only to the assertion of another medical light among the antivivisectionists, that brain tumors cannot be located outside the motor area.

MIDSHIPMAN AIKEN AND VIVISECTION [1]

An Open Letter to Hon. Jacob H. Gallinger, Chairman of the Senate Committee for the District of Columbia, Washington, D.C.

My Dear Sir, — As you have repeatedly introduced bills into the Senate for the purpose nominally of regulating experiments upon animals in the District of Columbia, which bills, however, if they had become laws, would in fact have prohibited many, if not all, of them, I deem it my duty to call your attention to the case of Midshipman Aiken, of the United States Naval Academy, who was recently injured in a football game.[2] My reason for doing so is to show you by a single concrete example that knowledge gained by animal experimentation is an immense boon to humanity and that, therefore, such experiments should be heartily encouraged.

The facts of Mr. Aiken's case are as follows: When I first saw him, three days after the accident, I found that he had been unconscious for a half-hour after the accident and ever since then had complained bitterly of headache, which he located always in the forehead. Mentally he was very dull, though not comatose. His pulse was slowed down to 52 instead of being 72, the normal. Soon after the accident he began to develop convulsions, first in the right leg, afterward in the right arm also, the right arm being finally the chief seat of the convulsions. When they were very severe they involved the left side also. The face was never involved. In six and one half hours after I first

[1] Reprinted from the Philadelphia *Medical Journal*, December 13, 1902.

[2] The facts had been already obtained without my knowledge by the reporters and published in the daily newspapers; hence I felt at liberty to describe the case publicly.

saw him he had twenty-four of these attacks, all limited to the right arm. They were not attended with any loss of consciousness. They exhausted him very greatly, especially when they were excessively severe. Several times it was necessary to give him chloroform.

There was no fracture of the skull. The only physical evidence of any injury was a very slight bruise at the outer end of the left eyebrow.

Had I seen this case before 1885, I should have been unable to explain why the spasms were chiefly manifested in the right arm, and from the evidence of the slow pulse, the headache, the stupor, the bruise in the left temple, etc., I should have been justified in inferring that probably the front part of the brain was injured at the site of the bruise. Had I opened his skull at that point, I should have found a perfectly normal brain and should have missed the clot. The young man, therefore, would have died whether his skull had been opened or not.

In 1902, observe the difference. As a result of the knowledge derived from experiments upon animals which have located precisely the center for motion of the right arm on the left side of the brain near the top and a little in front of a vertical line drawn through the ear, and disregarding entirely the site of the headache and the bruise, I reached the conclusion that there had been a rupture of a blood-vessel within the head, which had poured out a quantity of blood, and that the situation of the clot should correspond to the "arm center." The location of this arm center was far away (about three inches) from the location of the bruise, and its position was fixed absolutely as a result of experiments upon animals, confirmed later by many operations on human beings and also by *post mortems*. The operation was done on November 19, 1902.

As soon as the skull was opened at this point, the clot was found, its thickest point being exactly over the arm center, and nine tablespoonfuls of blood were removed,

with the result that the patient's life has been saved. The blood had first been poured out over the "leg center," which is located a little higher up than that for the arm. This explained the early spasms in the right leg. The clot did not extend, however, further down than the arm center. This explained why the face was never convulsed, for the "face center" lies just below that for the arm. [See Fig. 1, p. 48.]

I think if you were to ask the parents of this young man how many animals they would be willing to have sacrificed in order that their son might have his life saved, there would be no doubt of the answer. Indeed, had it been your own son, I cannot doubt the answer. But this is only one of hundreds of cases in which a similar exact localization has been made by many surgeons, both in Europe and America. Yet, by a curious coincidence, in the very same issue of a Baltimore newspaper containing a reporter's account of the successful operation on Midshipman Aiken, there is a letter signed by an active antivivisectionist agitator, which, among other misstatements and misrepresentations usually found in such publications, asserts that "brain surgery is disregarded."

If the laws which you and your friends advocate were in force, the conditions for scientific investigation in medicine in this country would be quite as deplorable as those in England. For example, when Lord Lister, who has revolutionized modern surgery, largely as a result of such experiments, wished to discover possibly some still better way of operating by further experiments, he was obliged to go to Toulouse to carry them out, as the vexatious restrictions of the law in England practically made it impossible for him to continue there these preëminently humane experiments.

Again, when Sir T. Lauder Brunton, in London, started a series of experiments on animals to discover an antidote for the cobra and other snake poisons of India, where every

year twenty thousand human lives are sacrificed by snake bites, these beneficent researches were stopped by the stringent British laws to protect animals. Meanwhile half a million of human beings have perished.

Who, I may ask, is the more humane; he who, doubtless with the best and sincerest motives of love for dumb beasts, would prohibit experiments upon animals and thereby prevent the acquisition of such knowledge and so compel surgeons to stand with folded arms and see innumerable lives thus needlessly sacrificed; or he who, by properly instituted experiments, would discover such new truths and apply them to the service of humanity?

The antivivisectionists have frequently denied that surgeons have learned anything from such experiments. I presume that I may be considered a competent witness as to the source at least of my own knowledge, and I state with the greatest positiveness that, without the knowledge derived from experiments upon animals which have demonstrated the facts of cerebral localization, I should never have been able to locate the clot in Mr. Aiken's head and to remove it, nor should I have been able in the last fifteen years to locate numerous tumors and other brain troubles and relieve many of them. What is true of myself is equally true of other surgeons.

In view, therefore, of the evident and positive benefit of such experiments, I trust that you will be willing to desist from further efforts at such repressive and, as I regard it, most inhumane and cruel legislation.

As this matter is of vital importance to the well-being of the entire community, I shall take the liberty of giving this letter to the press as soon as you have received it.

Very respectfully yours,

W. W. KEEN.

[This fine young man's later history is of great interest. In spite of my injunctions to drop back one year in the

Naval Academy he studied extra hard, made up all his lost time, graduated with his class, and entered the navy.

On January 10, 1909, over six years after the accident, he was examined for life insurance and was passed as "a first-class risk" and the policy was issued.

Six months later, July 11, 1909, he was killed by an explosion in a coal bunker on his ship, the North Carolina, lying in the harbor of Naples. He gallantly refused to let his men enter the bunker, where there was supposed to be a fire, until he had explored it himself. He saved their lives at the expense of his own.]

RECENT SURGICAL PROGRESS A RESULT CHIEFLY OF EXPERIMENTAL RESEARCH[1]

In October, 1889, and June, 1893, in "Harper's Magazine," I gave some account of the progress of surgery. In the sixteen years that have elapsed since my last paper was written there has been much further progress in various directions. I can only consider a very few of these advances, and even those in a very incomplete manner.

Surgery of the Heart

Up to the publication of Fischer's paper in 1867, scarcely any surgeon took the surgery of the heart seriously. That paper was based on a study of four hundred and fifty-two published cases of wounds of the human heart, and he showed that a patient might live for hours or even days with a wounded heart.

In 1881, Dr. John B. Roberts, of Philadelphia, made the bold proposal deliberately to sew up a wound of the heart, in spite of the fact that Billroth, the then most distinguished Continental surgeon, had declared that no one who wished to preserve the respect of his colleagues would ever attempt to operate on the heart. In 1896, after a number of experiments upon animals, two unsuccessful attempts to sew up a wound of the heart were published, followed happily in 1897 by Rehn's famous paper recording the first successful case. How quickly surgeons followed this happy lead is seen by the statistics given me by Dr. Francis T. Stewart (who himself has had a successful case), that up to June, 1908, one hundred and forty-one cases of wound of the heart had been operated on, and sixty-four of them had

[1] Reprinted by the kind permission of Harper & Bros. from *Harper's Magazine* for April, 1909.

recovered. When one considers the difficulties of such an operation, — the speed with which the heart must be exposed by making a trap-door through the chest wall, then dividing two or three ribs, without, if possible, injuring the left lung, opening the sac in which the heart lies (the pericardium), clearing it of blood, seizing the heart, and while it is actively pulsating, with a jet of blood from the wound at every pulsation obscuring the field of operation — when one considers these difficulties, and yet notes that over forty-five per cent have recovered, and that this percentage of recoveries is steadily increasing, it is a matter of both surprise and gratification.

In a good many operations, when chloroform and even sometimes when ether is given, the patient suddenly passes into collapse, the heart ceases to beat, the respiration stops a few minutes afterward, and death quickly follows. Whether the pulsation of the heart could be reëstablished was first investigated by Schiff in 1874, and in animals, by means of rhythmical compression of the heart by the hand, he succeeded in starting the heart beating. It is impossible for me to state in detail the experiments of Pruss in 1889 and Battelli in 1900, both of whom were able in a considerable number of animals and by various methods to reëstablish cardiac pulsation. The most extraordinary experiments, however, were made by Kuliabko in 1902 on hearts which had been removed from the body; all prior experiments having been made on hearts remaining in the body of the animal. Kuliabko showed that after the heart had been removed from the animal and kept in ice for twenty-four or even forty-four hours, by filling the heart with certain fluids pulsation was reëstablished and continued for over three hours. He was able also to take the hearts from rabbits that had died a natural death instead of having been killed, and on even the second, third, and fourth day after death, by filling them with this fluid the isolated heart was started pulsating and continued to beat

for several hours. He also tried the experiment in a number of instances in which the human heart was removed, *post mortem*, even as long as thirty hours after death, and produced temporary pulsation. In a dog's heart which had been in snow for eighteen hours, and again after having been frozen in salt solution for twenty-four hours, Velich obtained slight contractions, but full pulsation was not reached.

Very naturally such experiments aroused the hope that some similar result might be reached in man. Attempts were made in desperate cases of sudden death, especially from chloroform. Ricketts has collected thirty-nine cases, of which twelve recovered! In other cases the circulation has been reëstablished for a number of hours, so that the surgeons were justified in expecting the recovery of the patients, but after a time the pulse and respiration failed, and recovery did not follow.

As can easily be seen, all this is so new that it is impossible at present definitely to fix on the best method of reaching the heart, whether (as in cases of wounds of the heart) by making a trap-door over it in the wall of the chest, or by quickly opening the abdomen and reaching the heart through the diaphragm, or by other means which are too technical for me to describe. The report of the thirty-nine cases alluded to gives a recovery rate of thirty-one per cent. That this will be increased in time there is no doubt.

The most recent researches in the surgery of the heart are experiments on animals to determine whether it is possible not only to expose the heart and operate on its exterior, but deliberately to open its cavities and operate on the valves. The results so far seem to show that it is no dream of a surgical Utopia, but that some day "valvular disease of the heart," hitherto an absolutely incurable disease, *may* be dealt with surgically and with the possibility of success. Happy the surgeon who, after suitable experi-

ments upon animals have taught him exactly how to do it, may be able to cure such a hopeless malady![1]

But the happy history of progress is not yet all told. Three years ago I saw Dr. Crile, of Cleveland, chloroform a dog to death. By a suitable apparatus he was able accurately to record the very last pulsation of the heart and the last attempt at breathing. I stood by the dog, watch in hand, and when he had been dead — having neither pulsation of the heart nor breathing — for fifteen minutes, Dr. Crile injected toward the heart in the carotid artery a mixture of salt solution and adrenalin (the extract of a gland lying just above the kidney), compressed the dog's chest a few times, thus starting the heart and lungs going, and in less than three minutes the dog, though, of course, still unconscious from the anesthetic, was just as much alive as he had been a half-hour before. Partial but not permanent recovery has been obtained by Dr. Crile in animals even twenty-five minutes after actual death. If further experience confirms these results, we may have a better method of resuscitation in collapse of the heart than by exposing it as above described.

Without the experiments which had been made upon animals and proved the efficacy of the adrenalin, which was added to the salt solution, no one would have thought that the extract of a gland lying above the kidney would be of the least value in saving either animal or human life. We know now, as a result of such experiments, and with positive certainty the effect of the adrenalin and its immense value in these cases as well as in others.

Surgery of the Arteries and Veins

From the heart naturally we pass to the arteries, which conduct the blood from the heart to all parts of the body.

[1] Further progress has been made by Carrel in operating on the valves in animals, but it is not yet an operation so safe and certain as to warrant its use in man. (1914.)

Wounds of the arteries by gunshot, by stabs, by accidents, etc., are not at all uncommon. Until very lately when a large artery or a large vein was wounded our only remedy was to cut down upon the blood-vessel and tie it above and below the wound. If it were an artery leading to the arm, and still more if it were one leading to the leg, as the principal supply of blood was cut off, gangrene was a very common result.

In case of aneurysm (a disease in which the walls of the artery become weakened at a certain point, bulge, and finally rupture, producing death), till recently, as in the case of a wounded artery, our only resource was to expose the artery and tie it. Here again, for the same reason, the chief danger was gangrene. In the treatment of aneurysm, Matas, of New Orleans, has made the greatest improvement since the days of John Hunter, over a century ago. Instead of tying the artery above the aneurysm and arresting the current of blood in the artery, he opens the sac (that is, the dilated portion of the artery or aneurysm), and, if I may so describe it, sews the opposite walls of the sac together on the inside, leaving, however, a small tunnel through which the circulation is continued.

Up to June, 1908, eighty-five operations of this kind have been done, with seventy-eight recoveries. This method of operating obviates almost entirely the danger of gangrene. Thus far apparently European surgeons have neglected it, only two operations having been done in Italy and four in Spain, while the remaining seventy-nine have been done in America.

But it is in cases of wounds of arteries and veins that perhaps the most remarkable progress has been made, and the story shows how widespread are the benefits derived from a single discovery — how to sew together the two ends of an artery which has been cut across. When a blood-vessel was wounded, we were obliged to tie the artery or vein to prevent the patient from bleeding to death. As I have

explained, this cutting off of the blood-supply often produced gangrene. In 1894, Dr. Robert Abbe, of New York, made a number of remarkable experiments upon animals; among them two are especially noteworthy. Opening the abdomen of a cat, he cut across the aorta (the great blood-vessel passing directly from the heart to the lower limbs) and inserted a thin sterile glass tube, tying the aorta over flanges made at the two ends. After four months the cat was shown at the New York Academy of Medicine, "fat and strong, with the glass tube still in his aorta." Again, he almost amputated a dog's foreleg, leaving the limb attached to the body by nothing but the artery and vein. He then wired the two ends of the bone together, sewed muscle to muscle, nerve to nerve, etc., and after dressing the limb, encased it in plaster. After four months this almost amputated limb was perfectly united, and Dr. Abbe drew the inference that a completely amputated limb might be successfully grafted. How fruitful these experiments were in practice we shall see later.

When an artery is partially divided or completely cut across, naturally the proper course would be in the former case to sew up the wound, or in the latter to sew the two ends of the blood-vessel together, and so reëstablish the circulation. To describe all of the technical difficulties of such an operation would be impossible in a brief paper. They have been investigated experimentally by Murphy, of Chicago; Payr, of Graz; Crile, of Cleveland; Carrel, of New York; Guthrie, of St. Louis, and others.

The great difficulty has been to find a suitable method of sewing the two ends of a completely divided artery together in such a way that the *blood will not form a clot* at the necessarily somewhat rough and irregular line of union and *totally obstruct* the vessel just as if it had been tied. At last, within the past few years, especially by the labors of Carrel, Guthrie, and Crile, a suitable method has been devised by which now any surgeon, who will familiarize himself with

the process and obtain skill in its application by a few experiments upon animals, can operate in such cases with confidence. This method has not only found its chief application when the blood-vessels have been completely divided, but has made possible another very remarkable achievement; namely, direct transfusion of blood.

The older method of transfusion was to connect the artery of a healthy person with the vein of the patient by means of a rubber tube. The great danger here, as in the case of wounds of the artery, was that the blood would clot. If this clot passed into the vein, whether of arm or leg, it went upward till it finally reached the heart, and was then driven into the lungs, where it would act like a cork and block up a larger or smaller artery of the lung, cutting off the circulation in that part and producing a dangerous and in most cases a fatal pneumonia. So great was this danger and so frequent the disaster following indirect transfusion by this means that for a number of years it has been practically abandoned. Instead, therefore, of transfusing blood itself, surgeons have for some years relied upon supplying the loss in volume of the blood by means of salt solution, and this in very many cases has answered very well. As a result, however, of these recent experiments on the suture (sewing) of blood-vessels end to end, we now are in a position to pass the blood from the artery of a healthy person into a vein of the patient without any danger of its clotting, provided the operation is properly done.[1] This has had a very striking climax in certain cases in which there has been severe loss of blood. Let me give but one very briefly — the case of the baby of a well-known young medical man. Immediately after the birth of this baby, there set in severe hemorrhages from the mouth, nose, stomach, and bowels, the so-called "hemorrhage of the newborn." The various

[1] As a result of these and many other remarkable researches by animal experimentation, Carrel, in 1912, was awarded the Nobel Prize ($40,000) in Medicine.

remedies which were tried all failed, and on the fourth day the baby was dying. I am sure that every woman, especially, will sympathize with the grief of these parents over the impending death of their firstborn. In the middle of the night the father called Dr. Carrel, of the Rockefeller Institute, to his assistance, lay down alongside of his baby, an artery in the father's arm was laid bare and sewed end to end to a vein in the baby's leg, and the blood was allowed to flow from father to child. The result was most dramatic. A few moments after the blood began to flow into the baby's veins its white, transparent skin assumed the ruddy glow of health. The hemorrhage from every part of the body ceased instantly and never returned, and, as the published account [1] so vividly puts it, there was no period of convalescence — immediately before the operation, the baby was dying; immediately after the operation, it was well and strong and feeding with avidity. That baby to-day is a strong, healthy child.

The same method of direct transfusion has been used by Crile, Downes, of New York, and others, in a still different way. Many patients come to surgeons so weak, either from loss of blood or from the dreadful effects of cancer, tumors and other diseases, that to operate upon them with the coincident shock and loss of blood is almost sure to be fatal. In such cases very frequently prudent surgeons, to their great grief, are obliged to say "no," and allow the patient to die rather than attempt an operation.

In a child two years and two months old, Downes found a tumor of the kidney which filled the entire left half of the abdomen, and in whom the quality of the blood (the hemoglobin) was reduced to forty-five per cent of the normal; the child's face was drawn, the pulse rapid and feeble, and the appetite very poor. Operation was delayed for a few days in order to see whether good care and good food would not cause improvement. On the contrary, the child was no

[1] New York *Medical Record*, May 30, 1908.

better, and there was a measurable increase in the size of the tumor, so rapidly was it growing. On September 11, the father's artery and the child's vein were united and the blood allowed to pass from father to child for forty minutes. Every five minutes the quality of the blood of the child was tested by taking a few drops of it, and it was found that at the end of forty minutes the quality of the blood had risen from forty-five per cent to eighty per cent. The pulse was full and strong, and the child's color and general condition showed equal improvement. On the following day the tumor, weighing a pound and two ounces, together with the left kidney, was removed, and the patient was discharged perfectly well on October 18, having already gained three pounds in weight.

Crile has even, if possible, in a more striking way demonstrated the use of this method in eleven successful cases in human beings. Instead of effecting the transfusion a day or two before the operation, he has placed the patient and her husband alongside of each other at the time of the operation, connected the husband's artery with the wife's vein, and as soon as, from the inflowing blood, her condition has improved sufficiently to withstand the etherization, the shock, and the loss of blood, has proceeded with the operation. During the operation the loss of blood by the patient has been more than made up by her gain from her husband's blood, and she has been enabled to withstand the shock incident to the ether as well as the operation; and at the end of the operation she has been in better condition than before it was begun. As Crile has declared, "In some cases the results seem nothing short of a resurrection from the dead."

Recently a nephew of Bishop Lawrence, of Massachusetts, was thus rescued by direct transfusion of blood. To quote the Bishop's exact words, "The boy was at death's door, and is now in perfect health."

Transplantation of Parts of the Body

Our ability successfully to sew severed blood-vessels together has borne still further fruit. It has enabled us to transplant whole organs — for example, one or, in other cases, both kidneys, or an entire leg from one animal to another. These possibilities, however, have only been realized step by step, not only by devising successful methods of sewing the ends of large vessels together, but by discovering that nature can supply a transplanted part spontaneously with small blood-vessels and thus enable it to retain its vitality.

Everybody, for instance, knows about "skin-grafting." Reverdin, of Geneva, first snipped off little pieces of skin from the arm or leg and deposited these pieces on the surface of an ulcer, protecting them by suitable dressings from being displaced. He found that these little pieces when placed on the ulcer adhered to it, that they lived, that small blood-vessels nourished them, and around each little island of transplanted skin the ulcer began to scar over (cicatrize), and finally healed. This emboldened Krause, of Berlin, to take much larger pieces of skin, so that at present after removing a tumor, if we cannot bring the margins of the skin together, we cut from the thigh of the patient long strips of thin skin an inch wide and several inches long by means of a sharp razor and transfer them to the raw spot. As a rule, they adhere, preserve their vitality, are nourished by new small blood-vessels, and in a short time we can thus "skin-graft" a large raw surface and have it heal. The thing quickly heals.

But this kind of "grafting" is not limited to the skin. Many years ago Ollier, of Lyons, showed that by taking from the bone of a living animal a bit of the membrane which covers all bones (the periosteum), he could transplant it to another place on the same animal, or even into another animal, and the periosteum would produce new

bone. Following that discovery, which was the result of laborious experiments, we constantly now make what are called "subperiosteal" removals — for example, of a part or the whole of a lower jaw — preserving the periosteum, and from it a new more or less perfect bone is developed.

Recently Lexer, of Königsberg, has gone much farther. In the case of a man who had a stiff knee-joint bent at an angle and immovably fixed by firm bony union, he removed the bones forming the knee-joint and took from an amputated leg the healthy knee-joint and put it in place of the bone that he had removed from the stiff knee. The transplanted bones both above and below united firmly with the bones of the patient, and the strange knee-joint from the amputated leg served a perfectly normal function. In another case he removed the upper end of the shin bone, taking away, therefore, the lower *half* of the knee-joint (a much more difficult and dangerous operation, as it opened the knee-joint), and replaced this with a similar portion of bone from an amputated leg with entire success.

The last achievement that I have seen of this ingenious surgeon was reported to the German Surgical Congress in April, 1908. Most of my readers are familiar with the fact that when a patient, through disease or accident, has lost his nose a new one can be made for him. This is a very ancient operation. The new nose is usually made by cutting a flap from the forehead, leaving it attached by a footstalk between the eyebrows. This flap is then twisted on its footstalk and sewed in place. But it has serious disadvantages. Sometimes the twist in the footstalk is too tight; this compresses the blood-vessels, and the flap becomes gangrenous. In that case not only has the patient lost his nose, but he is left with a face disfigured by a great scar in the middle of his forehead. Even if the attempt to give him a new nose is a success, the scar on the forehead always tells the story, and, moreover, the new nose, having no bone, is flabby and unsightly. Lexer records a case which is

not only surprising, but one may say also amusing. Having a patient requiring a new nose, and having amputated a leg for some disease which did not involve the thigh bone, he took a bit of the lower end of this thigh bone, whittled it into the shape of a nose, and bored out two nostrils in it. He then made an incision in the skin of the forearm of the patient, on the front, or hairless surface, loosened the skin to some extent from the underlying muscles, placed the new bony nose under the skin, and closed the wound. After three months, when the skin of the forearm had become firmly attached to the bony nose (which was only intended to be a temporary tenant of his forearm) the skin and the new bony nose were cut out in one piece and transplanted to the face. This gave the patient a good, firm, bony nose, which at the same time was covered with the healthy skin of the forearm, and avoided any disfiguring scar on the forehead.

Even more surprising things have been done by Carrel and Guthrie in the transplantation of soft parts which had been preserved by various means, and yet grew fast and fulfilled their function. For example, in November, 1906, Carrel removed from the neck of a dog a portion of the carotid artery, and put it into cold storage, where it was kept at an even temperature of 32° to 33° F. After twenty days in cold storage he transplanted this into the aorta of a cat, and after two years and one month the cat was perfectly well. Again, in May, 1907, a portion of a dog's aorta was removed, and a similar portion of the artery behind the knee removed from the amputated leg of a man was put in its place, and eighteen months later the dog was still in thoroughly good condition.

Guthrie also reports that he removed from a dog a portion of the great vein alongside the aorta (the vena cava), preserved it by formalin (a chemical preservative) for sixty days, then removed a corresponding portion of the carotid artery from the neck of another dog and replaced it by this

portion of vena cava, and the animal was living and well when the report was made three weeks later.

Still more extraordinary experiments have been done by Carrel and Guthrie in the transplantation of entire legs or of entire organs. Carrel amputated the thighs of two dogs, A and B, and united the thigh from dog A to the stump of the thigh of dog B, wired the ends of the bones together, sewed artery to artery and vein to vein, etc. (it will be seen now how essential was the discovery of a successful method of sewing the arteries end to end), and applied a suitable dressing and a plaster cast. The new leg grew fast to the old stump, and when I personally saw it there was firm union.

This experiment, which has also been done by Guthrie, is only a further step, it will be observed, beyond the operation of Abbe in 1894, when he amputated the entire leg with the exception of the blood-vessels, which he dared not cut, for with the imperfect knowledge we poseesssd fifteen years ago he could not possibly have successfully sewed them together.

Quite as noteworthy also are some experiments of Carrel and Guthrie in which they have taken the two kidneys with their blood-vessels and the corresponding part of the aorta and the vena cava, the two ureters, and the part of the bladder into which the ureters entered, from one cat, and transplanted them into another cat from which the same parts had been removed. I saw this operation done a few months ago in an hour and a half. An hour after the operation the cat was in very much better shape than most of my patients are an hour after I am through with them. She recovered perfectly, and the transplanted kidneys worked as well in the second cat as they had done in the body of the original one.

Cancer

The surgical record of cancer consists of a happy achievement and a temporary failure. The achievement is the

practically permanent cure of forty to fifty per cent (and some surgeons have had even a larger percentage) of the cases operated upon: that is to say, patients who have had cancerous tumors removed have lived for five, ten, fifteen, and even twenty years without any recurrence. This has been gained by the most painstaking study of the modes of extension of the disease and by more thorough and earlier extirpation. I presume even now, with our imperfect knowledge of cancer, if every patient who found a lump in any part of the body would seek the best available surgeon, it would be within the bounds of truth were I to say that, taken at this early stage, the cures would probably amount to sixty-five or even seventy-five per cent of the cases operated on. But what all surgeons are seeking is (1) the cause and (2) the means of cure of cancer *without operation*—a professional altruism which I never cease to admire.

That cancer is mildly contagious is shown by the undoubted existence of the so-called "cancer houses" in which, for want of proper disinfection, repeated cases of cancer have arisen. Moreover, animal experimentation and a few cases in human beings have shown that if the cancer cells of the tumor come in contact with a fresh raw surface during operation, the disease may easily be spread in this way. Hence every modern surgeon is extremely careful to protect the raw surface of the wound from touching, even momentarily, the cancerous tissues or being moistened with their dangerous juices. For the same reason our operative methods, too, have been changed, so that now we take out the entire mass of infected glands as well as the original tumor in a single piece, and never put a knife into any of the cancerous tissues. If we are obliged to do so, this knife is cast aside and a new one substituted.

The cancer problem is being attacked vigorously in cancer laboratories in Buffalo, Boston, London, Heidelberg, New York, and elsewhere with extraordinary zeal. Many men are devoting their lives wholly to the study of this

one great and perplexing problem. It is being attacked on the clinical side to see if we can learn anything by such experience; by the microscopists to find if the minute study of the tissues will reveal the cause; by the bacteriologists to see if they can discover any germ which may originate the tumor; and finally by animal experimentation to study the life history of such tumors from start to finish by inoculating animals with the cancerous tissue and tracing the effect of the inoculation, destroying one animal at the end of a few days, another in two or three weeks, another in months, and so on; and in a multitude of other ways too technical to relate, in order to obtain the most intimate and exact knowledge possible. But so far the cause of cancer has eluded us.

I have called this a temporary failure because I look forward with confidence to the future. At any moment I am expecting to learn that some pathologist will really discover the cause of cancer (for many have cried, Lo here! or, Lo there! only to find they were in error), and thus confer a boon on the human race second only to the discovery of the bacillus of tuberculosis.

Let us now turn to another subject, in which, once more, the question of transplantation of organs will come up for consideration.

Goiter

This disease is well known, of course, to all who have traveled in Switzerland and Savoy, where such an immense number of cases occur. That it is not very uncommon in America is shown by the fact that the Mayo brothers have done over one thousand operations for goiter. In my paper in October, 1889, I referred to what was an amazing report in that year by Kocher, of Berne, of two hundred and fifty operations for goiter, with a mortality of but 2.4 per cent. The last statistics which have been published by Kocher cover three thousand operations for goiter, with the

marvelously low mortality of only three deaths in each one thousand cases.

When we began to operate on goiters, the whole of the thyroid gland (the enlargement of which produces the goiter) was removed. It was soon found, however, that in a certain percentage of cases the patients underwent a dreadful change; namely, they looked as though they were bloated; their hands and features became thickened and enlarged; their intellects became dulled, so that some of them even passed into the state of cretinism. Others, on the other hand, became greatly excited, and died with what is known as tetany, a disease which derives its name from its resemblance in many respects to tetanus or lockjaw. In order to obviate these dangers the first change that was made was to leave a portion of the gland behind. If this was done, the patient was not attacked by the general change (myxedema or cretinism), though fatal tetany still sometimes followed.

In 1880, Sandström discovered in the human subject some small glands about the size of grains of wheat, situated behind the thyroid gland, but in immediate connection with it, and therefore called the parathyroid glands. Human beings and many animals usually have four, sometimes three, and sometimes only two. Moreover, their situation varies very much, and at first it was impossible to recognize them at operation. What their function was, and what would be the effect of their removal, nobody knew. Accordingly, experiments were begun upon the lower animals by removing some or all of these glands in order to discover their function. It was quickly learned that when they were *all* removed, the animals died from tetany, just as human beings occasionally did after operations for goiter. Then it was suspected that the cause of the human tetany was not the removal of the thyroid gland itself, but of these little parathyroids, and that the good effect of leaving a part of the thyroid gland was due not only to

leaving the thyroid itself, but to accidentally leaving at least one of these little glands. Numerous experiments upon animals, as well as the terrible experiments which we had been ignorantly making upon human beings, from whom many surgeons, *without knowing it*, had removed these parathyroid glands, have shown that, small as they are, they are essential to life, and that if they are all removed, the withdrawal of the secretion they furnish to the body always causes death.

At the German Surgical Congress in April, 1908, Kocher reported that he had transplanted these glands for certain reasons into the upper end of the shin bone just below the knee. This he did first in animals, and found that when, at a later operation, he removed the whole of the thyroid gland and the parathyroids from the neck, the animals did not suffer from tetany. He has now gone a step farther, as his animal experimentation justified him in doing, and has done a similar transplantation in the human subject. The results of this operation have not yet been published, but I judge from his report to the Surgical Congress that it was favorable. If so, a new means of security is provided for us in operations for goiter.

There is another form of goiter, however, which is much more fatal than the ordinary goiter with which most people are familiar. It is called exophthalmic goiter, or Graves's Disease, the latter after Graves, of Dublin, the former because the eyes protrude very markedly. Along with these two symptoms there is a very fast pulse, running up to 160 or 200. The disease very frequently destroys life. It has been operated on by a number of surgeons with a good degree of success, but recently an antidote has been prepared by Rogers and Beebe of New York which seems to promise much in the way of cure and may possibly obviate operation. One of the gentlemen most interested in the development of this antidote was spurred on in his experiments by the fact that his own wife was suffering dread-

fully from the disease and rapidly nearing the grave. The idea of preparing this anti-serum or antidote had come to him while watching the action of another anti-serum, the whole effect of which was spent upon the kidney, no other organ of the body being affected. This suggested to him the idea that an anti-serum might be prepared from diseased thyroids which would have its sole effect upon the thyroid gland. Soon after this fruitful idea had developed in his mind, a patient with Graves's Disease died, and at the *post mortem* he obtained the thyroid gland from this unfortunate patient. With this a number of rabbits were inoculated, but in consequence of his total ignorance of the proper method of using it, all but one of these rabbits died. From this one rabbit there was prepared an extraordinarily good serum which absolutely cured three human beings and partially cured two others. The second of the three who were cured was the wife of the doctor himself. Her attending physician, one of great eminence, had declared to her husband that how long she would live was only a question of hours. By reason of the fact that its instant use was imperative before it could be thoroughly tested on animals so as to learn its dangers and how to avoid them, he nearly killed his own wife in the attempt to cure her; but she is to-day a perfectly well woman, thanks to the experiments upon this small number of rabbits.

Reckoned in rabbits, what is the value of your wife, your husband, or your child?

All of this animal surgery I mention for two reasons: first, because with minor exceptions the methods and the results of animal surgery and of human surgery are *identical;* and therefore, secondly, because it is a necessary preliminary and precautionary step to similar surgery in human beings. All of the recent surgery in animals above described will surely be applied, with suitable modifications, to man, immensely adding to his comfort and saving

life, with all which that implies for himself and his family.

This paper is a record of only a few of the wonderful achievements of modern surgery in human beings which have resulted chiefly from experiments on the lower animals. That clinical investigation — that is, investigation by observation at the bedside — has been of value, no one doubts; but had we been *restricted* to clincial observation only, not a tithe of the progress recorded would have been made. I scarcely know anything more touching than the story told me by Dr. Carrel of a boy who wrote to him, offering himself for experiments of any kind, if by so doing he could obtain a pension for his mother. Not long since I received a similar letter from a doctor who was afflicted also with a disease which he knew was mortal. He wrote me saying that he was willing to submit to *any* operation, however painful, *without any anesthetic*, if it could be of any use to humanity.

Moreover, this progress is not only in surgery, but in medicine; and doctors have been in the forefront in sacrificing their lives, sometimes by accident, sometimes voluntarily, in order to achieve these splendid results. Doctors have died by diphtheria, by plague, by infection of various kinds, have slept in the clothes and in the beds of yellow-fever patients in order to discover whether the fever was spread by these means, and have offered up even their lives in order to prove that yellow fever was caused solely by the mosquito, and thus clinch the proof that was needed in order that this dreadful scourge might be eliminated; a scourge which has cost a holocaust of lives and millions of dollars even in the United States alone.

As a result of the sacrifice of human lives Cuba has been freed from yellow fever for the first time in nearly two centuries, and in the Canal Zone not a case of yellow fever has occurred for over four years. Colonel Gorgas is the one man who has made the building of the Panama Canal a

possibility. No lower animal being subject to yellow fever, experiments could not be tried upon them, and hence Lazear and others lost their lives. In the fine words on Lazear's tablet in the Johns Hopkins Hospital, written by President Eliot: "With more than the courage and devotion of the soldier he risked and lost his life to show how a fearful pestilence is communicated and how its ravages may be prevented."

I am old enough, perhaps, to relate without reproach the following personal incident. While writing this paper a friend gave me the "Journal of Zoöphily" for January, 1909. On page 2 I found in an editorial note on a large gift by its founder to the Rockefeller Institute the following: "But the gift only fanned into fury the opposition of women to experiments on living animals, *no matter how great the anticipated benefit.*" Three days later, between noon and bedtime, I happened to meet four former patients, all of whom thanked me warmly for having saved their lives. Three of these four patients owed their lives chiefly to the knowledge derived from experiments upon animals. No further comment need be made on those cruel words — "No matter how great the anticipated benefit." With a thrill of delight I fervently thanked God for what modern surgery could do.

For what the friends of experimental research have done, and for what the foes of experimental research have done, see "The Influence of Antivivisection on Character," p. 234.

THE NEW SURGERY [1]

In "Harper's Magazine" for April, 1909, I gave a brief account of the newer surgery of the heart, the arteries, and the veins, and of the transplantation of different parts of the body, with some remarks on cancer and goiter.

Further transplantations of bone, such as Lexer's, which I there described, have been reported during the past year. Streissler, of Gratz, has published eighteen such cases; some of deformed noses made straight and comely by pieces transplanted from the shin bone of the patient, after being whittled into proper shape and size; others in which an inch or more of the arm bone has been removed for various reasons and the gap filled also by pieces of the shin bone. In fact, this bone seems to be the usual quarry from which can be had all the necessary building material for such operations. Of the eighteen cases all but one were successful, the limb becoming as strong and useful as before the operation.

In the present paper I propose to describe what has been accomplished in some other realms of surgery, which will show the remarkable progress made possible, especially with the aid of anesthesia, antisepsis,[2] and experiment.

Anesthesia

Anesthesia is produced in several different forms. (1) General anesthesia — i.e., insensibility to pain of the entire body; (2) local anesthesia, similar insensibility of a part of

[1] Reprinted by the kind permission of Harper & Bros. from *Harper's Magazine* for July, 1910.

[2] Consult the remarkable paper by President Charles W. Eliot, "The Fruits of Medical Research with the Aid of Anesthesia and Asepticism," delivered October 16, 1909 (Ether Day), at the Massachusetts General Hospital. Pamphlet No. IX, American Medical Association, Chicago. (See p. xix.)

the body; and (3) spinal anesthesia, insensibility produced by injecting an anesthetic around the spinal cord.

First, general anesthesia. On October 16, 1846, the first public demonstration of the use of ether for producing general insensibility to pain was made by Morton and Warren at the Massachusetts General Hospital, Boston. On November 17, 1847, chloroform was first used in surgery by Simpson of Edinburgh. On December 11, 1844, Wells had inhaled nitrous-oxid gas and had a tooth painlessly extracted, but it was not until 1867 that Colton brought the method into general favor by a report of twenty thousand successful inhalations.

The relative danger of these general anesthetics is about as follows: chloroform produces one death in two thousand five hundred cases; ether, one in sixteen thousand; and nitrous oxid, one in two hundred thousand. There are several other general anesthetics, but all of them have a larger death-rate than ether and chloroform. Nitrous oxid is by far the safest anesthetic, but the difficulty has been that one cannot perform long operations with it on account of the danger from asphyxia. To a certain extent this can be remedied by administering oxygen with the ether. Recently some surgeons have performed even very long operations by this method. Possibly this may prove to be a very important advance in practical anesthesia.[1]

Second, local anesthesia. In 1884, as a result of experiment upon animals (for what prudent man would be willing to have a new drug which might blind him applied to his eye without such a proof of its harmlessness?), Koller first introduced cocain in the surgery of the eye. From this beginning its use has become greatly broadened. We now inject a solution first into the skin itself and then into the subcutaneous tissue, and, by means of this "infiltration" method, can perform even large operations. About 1891,

[1] Crile and others have since perfected this method so that it is now (1914) extensively used.

Schleich in Germany showed the possibility of infiltrating the tissues with a very weak solution of one tenth of one per cent instead of two to ten or even twenty per cent as had been used at first, thus avoiding all the dangers of the stronger solutions.

In 1902, Braun conducted a series of experiments with a mixture of cocain and adrenalin. This added greatly not only to the duration, but to the safety of local anesthesia. Adrenalin is derived from a little body called the adrenal or supra-renal gland, which is situated immediately above the kidney. Adrenalin was first discovered by Takamine, a Japanese physiological chemist, in New York in 1901. Accurate experiments upon animals have shown that the effect of this powerful agent when administered in a very dilute solution is to contract the small blood-vessels in different parts of the body. But, strange to say, the blood-vessels of the lungs are not at all contracted, and therefore the supply of blood to the lungs and the function of respiration are not affected by the adrenalin. By its effect upon the blood-vessels elsewhere, however, the anesthetic action of cocain is greatly prolonged and also intensified. Hence its frequent use.

Another local use of cocain and several other similar drugs has been brought to the notice of surgeons in the last few years by Crile and Cushing; namely, the injection of a solution of cocain directly into the large nerves of the body before dividing them, in the case of an amputation. For example, in any amputation above the knee, or at or above the shoulder joint, we have to divide nerves which are as large as a lead-pencil, or even a little finger. Accurate observation both in animals and man has shown that when these nerves are divided a great fall takes place in the blood pressure, to such an extent in some cases as even to threaten life very seriously. This dangerous shock is produced even when the patient is fully etherized. But it has been found that if a solution of cocain is injected into the

nerves supplying the arm or the leg *above* the point at which the nerves are to be severed, these large nerves may then be divided with impunity and without the least shock, since the cocain "blocks" the sensory impulses going to the spinal cord and brain when the nerves are cut.

Third, spinal anesthesia. Lately spinal anesthesia has attracted great attention, and has been widely exploited by the press, and many inaccurate notions have been published. The facts are as follows: From the initial trials, by Corning in America in 1885, there has been developed the method which we now know as spinal anesthesia. In 1891 Quincke, of Kiel, first introduced what we know as "lumbar puncture"; that is to say, the introduction of a long hypodermic needle between the vertebræ into the sheath which includes the nerves at the lower end of the spinal cord, for the purpose of withdrawing some of the cerebro-spinal fluid which surrounds the spinal cord and is continuous with that within the skull. The object that Quincke had in view was that of diagnosis. By this procedure, now constantly used, we are able to determine whether, in cases of brain tumors and some other conditions, this fluid exists under a higher pressure than is normal; whether the fluid contains blood, and therefore indicates hemorrhage either around the spinal cord or even within the skull; and again, by microscopic and bacteriological examination, whether the fluid contains any bacteria which are capable of producing disease. This has now become a well-established method of investigating and diagnosticating a number of diseases, the most noteworthy, perhaps, being cerebro-spinal and tuberculous meningitis. From the use of the method for diagnosis, however, it was a very easy step to treatment, for by the same needle by which one withdraws the cerebro-spinal fluid it would be possible to inject various remedies. Thus the mortality of cerebro-spinal meningitis has been diminished from sixty per cent or even ninety per cent down to twenty-five per cent or less by the injection of the serum

discovered by Flexner and Jobling at the Rockefeller Institute.

Naturally one of the obvious questions would be whether the injection of cocain directly into the sheath of the spinal cord, thus bringing it into direct contact with the nerves from the cord, would not produce anesthesia of all the body below the point of injection. The answer given by experimental research was that it would.

Spinal anesthesia has now reached a stage of practical utility. The injection is made into the lumbar region (the small of the back) between the vertebræ. Cocain now is rarely used, because of its danger. Stovain was used for a considerable time. Since then novocain and tropacocain have replaced it, as they are found to be much less dangerous.

Recently Jonnesco has advocated applying this method even as high as between the shoulders, and has thought that the danger of stovain was much diminished by the addition of a small amount of strychnin to the stovain. But experience in a large number of cases has shown that Jonnesco's method is far from being devoid of danger.

One can easily understand that there are dangers peculiar to this method of anesthesia. A tubular needle is a very difficult thing to disinfect thoroughly, and infection of the cerebro-spinal fluid would be a very serious danger. In some cases the needle itself has broken off, requiring a serious operation to remove the broken point. Palsy of the lower extremities and, curiously enough, palsy of the muscles of the eye have followed in a few cases. But the chief danger is that of collapse, and especially failure of the respiration. The nervous center which governs breathing is situated in the spinal cord immediately below the base of the skull. The cerebro-spinal fluid, as a rule, circulates freely up and down around the spinal cord and into the cavity of the skull. With the patient lying down, and especially if the shoulders and head are lower than the rest

of the body, the solution of stovain or cocain, etc., gravitates toward this respiratory center, and when the drug reaches this center and anesthetizes it, it may easily produce collapse and failure of the respiration, which are very serious dangers. Even in Jonnesco's own hands, in several cases operated on recently in this country, death was only averted by the prolonged use of artificial respiration.

In view of all these possible dangers and complications, prudent surgeons restrict the use of spinal anesthesia in two ways: (1) They are unwilling to inject it at a point above the small of the back (i.e., the lumbar region) for fear that it may reach the respiratory center, and (2) they limit its use to the exceptional cases in which the use of ether, chloroform, or nitrous oxid is attended with unusual danger, and therefore contra-indicated. Within this limited field spinal anesthesia has a distinct value. Beyond this field it may hereafter be made less dangerous and therefore more widely applicable, but that can only be as a result of further experiment and observation.

Alluring as it unquestionably is to be able to have an operation performed on one's self without the loss of consciousness — a condition to which there is often a very natural repugnance — the preservation of consciousness during an operation is a distinct disadvantage in most cases. As I said in 1907, "to have the patient aware of surgical emergencies, which frequently arise and which often test a veteran operator's skill and resources to the utmost, would frequently invite death by the terror which it might occasion. Even the usual emergencies of hemorrhage, etc., which attend almost every operation and which are easily conquered by the surgeon, would frighten most patients. The ideal anesthetic, hereafter undoubtedly to be discovered by experimental research, *will abolish pain by the abolition of consciousness, but without danger to life.*"

Surgery of the Nerves

I have already alluded above to the blocking of sensation in nerves in cases of amputation by the injection of a local anesthetic directly into the tissue of the nerve. Twenty years ago operations on nerves were very few. At present they are constantly performed. As long ago as 1863 Phillipeaux and Vulpian by experiments upon animals proved that by uniting nerves which had been divided the function of the nerve might be reëstablished. Until these experiments had proved it, there would be a natural fear that if we sewed the two ends of a severed nerve together, the needle puncture and the thread, which must remain in the nerve for a considerable time, might inflict serious or even lasting injury. Indeed, it was supposed at that time that very possibly lockjaw might follow; for that lockjaw was only caused by a special germ was then unknown. It has been proved, however, on animals, that these supposed dangers did not follow, but that severed nerves could be sewed together without harm. In case a patient in falling puts his arm through a pane of glass and the broken glass divides the sinews (tendons) and the nerves at the wrist, where they lie just under the skin, in view of our present knowledge it is the bounden duty of the surgeon who first sees the case to sew the divided sinews end to end, and, what is quite as important, if not more so, to sew the divided nerve ends together in order to avoid permanent paralysis. If this is done promptly, success is almost the rule. Even if this has not been done and the severed nerve has remained ununited for weeks, months, or in some cases for years, it is possible in not a few cases to restore the function of the nerve and cure the paralysis by sewing the ends together.

One nerve in the arm, the musculo-spiral, so called because it winds among the muscles in a spiral fashion around the upper arm bone, is peculiarly liable to injury, for in-

stance, by a stab wound by a pocket-knife or a gunshot wound. But the most frequent source of injury to this nerve as it winds around the bone itself is fracture of the arm bone about midway between the elbow and the shoulder. In some cases the nerve is torn to such an extent that the two ends when they are dissected loose at operation are separated by a considerable interval. If this interval is not too large, by stretching the nerve above and below the point of injury we can bring the ends into contact and sew them together. In other cases, however, the gap between the two ends is too wide for approximation of the two ends. In this condition there are various ways of accomplishing union of the nerve. Among them, in a number of cases, surgeons have deliberately laid bare the bone, sawed out an inch or more of the bone, and wired the ends of the bone together. This shortens the upper arm to such an extent that, with stretching, the two nerve ends can be brought into contact and held in this position by sewing them together; after the wound is dressed splints are then applied to the arm as in any ordinary fracture. This operation, especially if done early enough, is followed by a considerable, and in some cases practically a perfect, recovery of function — a useless arm is made useful again.

The bundle of nerves which originate from the spinal cord in the neck and are distributed to the arm are also specially liable to injury. Occasionally, in fracture of the collar bone, these nerves are seriously injured. In other cases, by a fall on the shoulder — for instance, from a bicycle — one or more of these nerves are completely torn across. This is the condition which we now know occurs in a great many cases of the so-called "birth palsies," in which one arm from the time of birth hangs flabby and useless. Unless the condition is remedied, it means a useless arm during the entire life of the patient. Only within the last few years has this condition been recognized as due to rupture of the nerves, and attempts have been made to remedy

the serious disability following the injury. The nerves have been exposed, and where they have been torn apart the ends have been sewed together with the very gratifying result in a number of cases of a partial or, in some cases, practically of complete restoration of function of the arm.

Of course in all of these cases of wound or other injury, as a rule, the earlier the operation is done the greater the prospect of success, but in a number of cases not only several months but sometimes years have elapsed before the operation has been performed, and yet restoration of function has followed. After the operation, subsequent treatment by massage and the use of the various electrical currents are quite as important as the operation itself, and should be persisted in for a year or even two years before giving up all hope of success.

The muscles of the face are all supplied by what we know as the seventh or facial nerve. This comes through a canal in the base of the skull very close to the mastoid process (the bony lump behind the ear), emerges from the bone just behind the lobe of the ear, and then spreads out fanlike over the face, supplying all of its muscles. A stab wound or gunshot wound just below or just in front of the ear not uncommonly paralyzes one side of the face by destroying this nerve trunk. Occasionally, unavoidably, in the well-known mastoid operation for ear disease, the same nerve is injured. Only within fifteen years, by a happy thought, first, Ballance, of London, then Kennedy, of Glasgow, Bardenhauer, of Cologne, and a number of surgeons in America and elsewhere, have treated this condition surgically, and the unsightliness of a face with the usual expression on one side, but motionless and expressionless on the other, has been remedied. This relief has been made possible in consequence of the studies of the union of divided nerves in animals and the means of their regeneration — i.e., restoration to their normal power.

In the neighborhood of the facial nerve run two other

nerves of about equal size; one (the hypoglossal) going to the tongue; the other (the spinal accessory) going to certain muscles of the neck. In cases in which the destruction of the facial nerve has been so extensive that the two ends could not be united, one of these two uninjured nerves just mentioned is partly or completely divided, and the end of the facial nerve which goes to the muscles of the face hitched on to the facial or hypoglossal nerve. In quite a number of cases the face has recovered its expression and the muscles their ability to contract.

Surgery of the Chest

The surgery of the great cavities of the body — i.e., of the head, of the chest, and of the abdomen — has advanced at very different rates of progress. The surgery of the abdomen was the first of these three regions to show immense progress as a result of the introduction of anesthesia, antisepsis, and experiment. Only a little over twenty years ago did the surgery of the head begin to make any serious progress. The surgery of the chest, until within the last very few years, has been almost at a standstill. One reason for this is the character of the contents of the chest. They are, the esophagus on its way from the mouth to the stomach; the lungs covered by the pleura; the heart in its sac (the pericardium); and the enormous blood-vessels, some conveying the blood from the heart to all parts of the body by the arteries (the aorta and its branches), some bringing it back to the heart by the great veins (forming the greater circulation), and others going from the heart to the lungs and coming back to the heart from the lungs (the lesser circulation). These are the largest blood-vessels in the body; they are nearly as large as the thumb, and any interference with them is so dangerous that until very recently it has never been attempted.

Moreover, there is another peculiar feature about the chest which makes it very dangerous and difficult for sur-

geons to operate within that cavity. The chest, by means of the motion of the ribs and the diaphragm, practically acts like a bellows, drawing the air into the lungs through the mouth and nose (corresponding to the nozzle) when the diaphragm descends and the ribs rise, and expelling the air in the reverse way when the diaphragm and the ribs reverse their action. If one made an opening in the chest wall, it was like making an opening in the side of a pair of bellows, but with one serious difference. The air would rush into the cavity of the chest through this artificial opening, would surround the lungs in the pleural cavity, *but would not get inside the lungs to aërate the blood*, and the lung itself would collapse because suction by the diaphragm and ribs was no longer possible. Moreover, pleurisy of a violent and often fatal form was always a possibility. And yet there was urgent need for remedial surgery in this region. Patients, especially children, very frequently inhale "foreign bodies," which pass down the windpipe into the great bronchial tubes, going each to its respective lung. They often lodge so far down as to be inaccessible through the mouth, or even through an opening into the windpipe (tracheotomy). If the foreign bodies are swallowed, they pass down the esophagus and may be arrested at any level in the chest. Then again frequently pleurisy passes into that form in which a large amount of pus (matter) accumulates in the pleural cavity around the lung and should be evacuated. Abscesses form in the lungs as a result of pneumonia or of other causes. Gangrene of the lung occasionally occurs. In consumption great cavities are formed in the lungs, which ought to be drained or otherwise dealt with. Besides all these there are gunshot wounds, stabs, and other accidental injuries. Yet the surgery of all these conditions was in the most backward state till very recently.

At the meetings of the American Surgical Association and the American Medical Association in 1909, several papers were read dealing with the surgery of the chest, such

as sewing up the lungs when they have been wounded, removing diseased parts of lungs, removing large portions of the wall of the chest, etc., with extraordinary ease, compared with a few years before, and with surprising success.

Urged by the necessity of removing foreign bodies that lay in the bronchial tubes, various experimenters attempted to reach them by direct operations either through the chest wall from in front, from behind, or at the side of the chest. Experiments were made upon lower animals to see which of these modes of approach was the least dangerous, the most expeditious, and most satisfactory, but *all* of them were found to be exceedingly dangerous, and were only resorted to when the dangers of not doing anything exceeded the dangers of attempting to do something.

Within a few years, however, what is called "bronchoscopy" has been practiced with the greatest success. When a tack or other foreign body has been inhaled, we now can introduce a long straight tube between the vocal chords down the windpipe to the point where the windpipe divides into the two bronchi to the right and left lungs, and by means of powerful electric lights can then see the foreign body, and can even pass the tube into the right or the left bronchus, and by means of suitable delicate instruments passed down through the tube can seize and extract this foreign body. This is a vastly less dangerous and vastly more successful method than the older one of tracheotomy, but as yet relatively few surgeons are masters of the method.

When the foreign body, however, is beyond the reach even of such an instrument, then the only possible way to extract it is through the lung by an opening in the chest. In 1904, Sauerbruch in Breslau constructed an air-tight chamber from which the air could be exhausted or compressed to any extent. Only the body of the animal was placed in the chamber; the head protruded through an opening with a rubber collar around the neck so that the animal could

be etherized from the outside. Inside the chamber there was room for the surgeon and his assistants, instruments, etc. Control of the amount of exhaustion or compression of the air was obtained through an electric motor operated from within the chamber, and a telephone gave ready means of communicating with those outside. Various modifications of this have been made, the last by Dr. Willy Meyer, of New York. He has shown that the pressure of the atmosphere as indicated by the barometer in New York varies normally between that at sea-level and that which corresponds to an elevation of one thousand seven hundred to two thousand feet; but in the chamber he has devised to open the chest safely it is only necessary to exhaust the air to what corresponds to an elevation of two hundred and fifty or three hundred feet, about the height of many modern "sky-scrapers." In this chamber he has removed part or all of one lung in twenty-six dogs, with twenty-two recoveries — 84.6 per cent.

Last year, also, Meltzer and Auer at the Rockefeller Institute devised still another method of respiration that may possibly render even such a chamber in many cases unnecessary. By "ventilating the lungs," or "tracheal insufflation" as it has been called — i.e., by introducing a tube into the windpipe and forcing a gentle current of air charged with a certain amount of ether vapor into the lungs — they have found that all the necessary respiratory changes of oxygen, carbonic acid, etc., go on, and the animal can be kept alive for hours *without any movement whatever of the chest in breathing.* Utilizing this method, Carrel has done some extraordinary work on the aorta, the great blood-vessel which carries all the blood from the heart to the entire body and in man is as large as the thumb. He has divided it at different levels, clamping the aorta above and below the point of division to prevent hemorrhage, long enough to sew the ends together, has incised and even cut away portions of the aorta, and done other remarkable

surgical operations, from which the animals in most of the cases reported recovered.

In February last I saw him thus freely open the entire chest from side to side, operate upon the aorta, and manipulate heart, lungs, and other organs in the chest with the same facility and safety as we handle the various organs in the abdomen. The operation lasted an hour and a half, and an hour later the dog had entirely recovered from the ether, and was doing better than a human being after most capital operations.

Thus a wholly new chapter in the surgery of the chest and its great blood-vessels has been opened.

These advances in the surgery of the chest in animals will lead quickly to very great advances in the surgery of the chest and its contained organs, the heart, the lungs, the esophagus, and even the aorta, in man. In fact, already more than a score of cases have been operated on, usually in a Sauerbruch chamber. A most extraordinary case was reported at the German Surgical Congress in April, 1909, by Von Eiselsberg, of Vienna. A man stabbled himself repeatedly in the chest with a pair of sharp scissors. He was brought to the hospital and operated upon in a Sauerbruch chamber within an hour after the accident. He was already unconscious, so that no anesthetic was needed, was pulseless — in fact, was dying. The chest was opened widely, the lungs drawn aside; the heart and its great blood-vessels could be readily seen and manipulated. It was discovered that the scissors had made a considerable rent in one of the great blood-vessels carrying the blood between the heart and the lungs. This was sewed up with six stitches, and the man survived for fifty-four days — almost eight weeks. This is the first operation on man of this kind ever recorded. Had the operation been done deliberately, with all the necessary antiseptic precautions, there is little doubt that the man would have survived; but when life is ebbing away with the lapse of every

moment, one is between the Scylla of too great haste and therefore possible infection, and the Charybdis of too great delay for proper disinfection while the patient is dying from hemorrhage.

Occasionally the blood suddenly forms a clot in the great artery carrying the blood from the heart to the lungs, thus arresting more or less completely the aëration of the blood. This accident is necessarily fatal, sometimes so quickly that nothing can be done. But in most of the cases death does not follow for fifteen to forty minutes, and occasionally for an hour or more. After experiments upon animals, which he reported in 1907, Trendelenburg, of Leipzig, believed it to be possible to rescue some of these relatively slow-dying cases. The next year one of his patients, a woman of seventy, suddenly collapsed, and was evidently dying. Fortunately he lived only eight minutes away. He was called by telephone, and in eighteen minutes after the first symptom the operation was begun, and in five minutes more the chest had been opened, the artery exposed and opened, and the clots removed. This was the first case of this kind ever operated upon. But the patient was too old and too far gone for recovery.

The second operation was done by Trendelenburg's assistant, this patient living for fifteen hours. Kruger has recently reported a third case, who lived for five and a quarter days.

With constantly improving technic, success is sure to follow before long, just as it has followed many early failures in operations for typhoid perforation, goiter, cancer of the stomach, and many other operations. Thus from 1849 to 1875 the stomach had been operated on for cancer twenty-eight times with twenty-eight deaths. The twenty-ninth case, in 1875, was successful. The operation has gradually become more and more successful as our technic has improved, till now the great majority of the patients recover.

That valvular disease of the heart may in time come within the domain of surgery I have little doubt.

Some cases of cancer of the esophagus, also, heretofore absolutely abandoned to death, have been operated on, but with only fair success thus far.[1]

Ulcer and Cancer of the Stomach

To attempt to give any idea of the advances made in the surgery of the various organs contained in the abdomen in the short space at my disposal is hopeless. I can only consider a few special points.

Among the most important are ulcer and cancer of the stomach. It is now well established that most cases of cancer of the stomach originate from a chronic ulcer. This ulcer has two distinct dangers besides that of a possible cancerous degeneration. Not seldom the ulcer eats into one of the large blood-vessels, just as in consumption the same process in the lung opens one of the large blood-vessels of the lung. In either case a more or less profuse and always dangerous hemorrhage takes place.

In cases of chronic trouble with the stomach, surgeons are not now disposed to wait until a profuse hemorrhage announces the presence of an ulcer, but they open the abdomen and then open the stomach, search for the ulcer and treat it. This avoids or remedies, as the case may be, not only hemorrhage, which is so dangerous, but another danger, namely, that the ulcer will eat its way entirely through the wall of the stomach and suddenly allow the contents of the stomach to escape into the general cavity of the abdomen. This is invariably followed by a fatal peritonitis unless operation is undertaken at once. The number of cases in which, after such a perforation, operation has been done is now very large, and when it is done

[1] See the paper on "The Influence of Antivivisection on Character" (p. 234) for a later and fuller account of the recent progress on the surgery of the chest by means of experiments upon animals.

promptly, within say a few hours, the percentage of recoveries is very large.

Cancer is very apt to attack the stomach at the orifice of exit called the pylorus, where the food passes into the upper intestine. When cancer develops here, this opening is gradually narrowed until no food can escape from the stomach. All that the patient swallows remains in the stomach, undergoes decomposition, and creates the greatest possible distress in addition to the pain of the cancer. In these cases, if we cannot remove the cancer, we make an opening in the stomach and an opening in a nearby loop of the upper bowel, sew the two openings together, and in that manner side-track the food past the obstruction precisely as the Welland Canal passes around the obstruction to navigation by Niagara Falls.

If we could only make a diagnosis of cancer in the very earliest stages, it would be possible in most cases to remove the cancer and have patients recover. In a very considerable number of cases parts, and in a few cases all of the stomach have been removed, the esophagus and the intestines have been sewed together, and while many of the patients have died, a number have recovered and lived for months and in some cases for a much longer period. In the past few years the percentage of recoveries has increased very encouragingly.

The difficulty is in *making a diagnosis before the disease has advanced to the stage when, by adhesions to neighboring organs and infection of the glands, removal of the cancer with any hope of permanent success is practically past.* When a case of marked indigestion has been rebellious for a number of weeks, surgeons are more and more inclined to open the abdomen and by actual inspection and palpitation of the stomach to determine whether it is cancerous or not. In these early stages the removal of the cancer is not an extremely dangerous operation. Such an "exploratory" operation is fully justified, for if no cancer exists, prac-

tically all of the patients recover, and not seldom the surgeon, even if he finds no cancer, does find adhesions, ulcer, or other difficulty which can be remedied. Ulcer precedes cancer in about two cases out of three, and probably even more; perforation of the stomach by an ulcer occurs in about one case in five. The average of recoveries after perforation, if operated on very promptly, is about three out of four; later it is reversed — three out of four die by reason of the delay.

Surgery of the Intestines

Cancer is not by any means limited to the stomach. It not uncommonly attacks the intestine. Here again an "exploratory" operation is often necessary. If we can catch the disease in its early stages, we can remove large portions of the intestine and by various devices can restore the continuity of the intestinal canal and save the patient's life. The only safety for the sufferer in these cases lies in *early* operation. When operation is deferred, we are almost sure to find that it is impossible to remove the disease, and we have to resort again to the device above spoken of, to side-track the intestinal current by making one opening above the cancer and another below it and sewing the two openings together. As in the similar operation between the stomach and the upper bowel, life is not permanently saved, for the cancer remains, but life is prolonged for months and sometimes even for years, and the immense comfort that is given to the patient fully justifies the procedure, which is not very dangerous.

In not a few cases of accident, when, for example, the wheel of a wagon runs over the abdomen, though the abdominal wall may not be ruptured, rupture of the intestine takes place, allowing its contents to escape into the general abdominal cavity. So, too, when a stab wound or a gunshot wound is received, a similar escape of intestinal contents may take place. In these cases, where the evi-

dence from the symptoms is fairly clear, so safe is abdominal surgery in these antiseptic days, we do not hesitate to open the abdomen, seek for the point of rupture, or of the wound, and either, if it be small, sew it up in the proper way, or, if too large for this procedure to be safe, we cut out the torn portion of the intestine and unite the two ends. In fact, it is surprising that of twenty-five feet of the intestine almost one-half has been successfully removed. In gunshot wounds, as many as eighteen perforations have been closed and the patient has recovered.

One of the most desperate, frequent, and fatal complications of typhoid fever is perforation of the bowel. In typhoid fever ulcers form in the intestines, and in a large percentage of cases, as in ulcer of the stomach, an ulcer eats into a blood-vessel, producing profuse hemorrhage which may destroy life, or if it eats a hole entirely through the intestinal wall, the deadly intestinal contents then escape. It is serious enough to operate on a healthy patient who has had a hole torn in his intestine, but when in addition to the perforation we have to operate on a patient who is desperately ill with typhoid fever, even the stoutest heart might well shrink from it.

The first operation for such a perforation ever done was by Mikulicz, of Breslau, in 1884. The mortality originally was about three out of four. Several hundred cases operated on have now been published, and the mortality has gradually fallen to about sixty-five per cent. In other words, one out of three recovers instead of one out of four. This seems a terrible death-rate, and at first blush one might almost believe that no operation ought to be done if two out of three or three out of four die; but remember the alternative — if no operation is done, practically a hundred out of every hundred die. Operation, therefore, distinctly saves every case that recovers. A few hospital surgeons, very favorably situated as to facilities, have been so fortunate as to save about one half of the cases operated on. In

seventy cases of operation in children under fifteen, collected by Jopson and Gittings, there were only thirty-one deaths — a recovery rate of fifty-six per cent. With speedy operation (always if possible within a few hours) and suitable methods, the next few years will undoubtedly show a general mortality of only fifty per cent or less, and every case that recovers owes his life to modern antiseptic surgery.

Heretofore, in searching for perforations or ruptures, surgeons have constantly drawn part or often all of the intestines temporarily outside of the abdominal cavity, without a thought that the patient would suffer any harm by such a procedure. We used no especial care in manipulating the intestines, particularly when haste was needful on account of hemorrhage.

But Crile has studied on animals the deleterious shock produced by any rough handling of the bowel or by pressure upon it, and Cannon, of Harvard, has recently reinforced Crile's conclusions. They have shown that mild, moderate, or rough handling of the bowel (always under an anesthetic of course) produces very pronounced shock proportionate to the roughness of such handling.

Hence in all abdominal operations nowadays — e.g., for appendicitis, etc. — surgeons are most careful to handle the intestines with the greatest gentleness, and never displace them outside the abdomen if it can possibly be avoided, with the result that the mortality of abdominal surgery is always steadily decreasing.

Surgery of the Liver and Gall-Bladder

The liver is liable to stab wounds, gunshot wounds, and also to be torn when a patient is run over by a wagon, cart, etc. Besides the danger of infection by bullets, dirks, etc., which is very great, the danger of death from hemorrhage always exists. Hence if there is good reason to believe that the liver has been wounded or torn, the abdomen

should be opened very quickly, the hemorrhage arrested, and the abdominal (i.e., the peritoneal) cavity cleansed. If done promptly, a very large percentage of the patients recover. To show how in this as in other operations increasing experience, by disclosing errors and establishing better methods, results in a diminishing rate of mortality, in 1887 the mortality was as high as sixty-six per cent; in operations done between 1895 and 1905 it has fallen to forty-four per cent.

Non-cancerous tumors of the liver have been very successfully removed in the last few years, sixty-three out of seventy-six early cases having recovered, while in later cases the results are even better. Cancer of the liver, however, is practically always fatal.

The gall-bladder, which is simply a receptacle for the bile, has now been successfully removed in so many cases that it is rather puzzling to know why we have any such organ. The bile in this storage reservoir is often infected by bacteria. Such an infection is probably the rule in typhoid fever, and even many years after the patient has recovered from such a fever the bile is still infected and not seldom becomes a serious menace to life. In addition to other causes, typhoid and other germs frequently cause gall-stones to form in the gall-bladder. These are concretions formed from the solid constituents of the bile. Often they are only one, two, or three in number, but in some cases they number hundreds and even thousands of very small stones. Women are far more liable to gall-stone disease than men — in the proportion of three or even four to one. Tight lacing has been accused of being one of the most potent causes.

If gall-stones cause trouble, they should be removed by operation. In competent hands this is now attended with a mortality of from one and a half to say five per cent, depending on existing complications.

Peritonitis

Rupture or perforation of the stomach or intestine, from whatever cause, unless speedily operated on, always sets up a general peritonitis. Until within the last few years, when this diagnosis was made, it was equivalent to a verdict of death. Even if operation was done the patients almost all died. But in the last few years, thanks especially to the American surgeons, Murphy, of Chicago, and the late Dr. George R. Fowler and his son, Dr. Russell S. Fowler, of Brooklyn, this almost hopeless picture has been changed to one of great encouragement. It is needless to enter into details of the treatment, but it may be summarized for popular knowledge in this way: It has been found that the poison of pus (matter) in the abdomen is much more readily absorbed in the upper part of the abdomen next the diaphragm, and much less readily absorbed in the lower part of the abdomen. Hence we raise our patients suffering from peritonitis in bed, sick as they generally are, to two thirds or three fourths of the sitting position, and then slowly for hours flush the interior of the intestine with salt solution delivered very gradually but almost continuously. As much as two or three gallons of the salt solution may be absorbed within the twenty-four hours. At the present time, therefore, even when the specter of general peritonitis is present, the case is by no means hopeless, but, thanks to the greatly improved treatment of modern days, and also to American surgery, it is full of hope.[1]

Hernia or Rupture

One of the commonest surgical conditions in the human

[1] Dr. R. S. Fowler writes me that by this method and by earlier operating, his mortality has gradually fallen from thirty-eight per cent to seven per cent in his last one hundred cases as against about seventy-five per cent before this treatment was adopted. (1914.)

body is hernia or rupture. In the wall of the abdomen there are a few openings to let arteries and veins and other structures pass out of or into the abdominal cavity. When these apertures — or "rings," as we call them — are not securely closed a knuckle of bowel often protrudes through the opening. This is a hernia or rupture. For many years after I graduated, in 1862, sporadic attempts were made to remedy this condition by operation, so as to spare the patient not only the life-long annoyance of a truss, but the ever-present danger that more bowel would be forced suddenly through the opening in the wall of the abdomen as a result of sudden muscular strain in lifting something heavy, and become gripped by the opening, or what we know in surgery as "strangulated"; that is to say, so constricted that gangrene of the bowel and death were inevitable unless relief was afforded.

Until the antiseptic method was thoroughly grounded and established in the profession, no really successful methods to cure this condition had been devised, for the reason that until the advent of antisepsis every surgeon was afraid, and rightly afraid, of opening the abdominal cavity on account of the exceedingly great danger, or, in fact, almost certainty of peritonitis. About twenty-five years ago, however, attempts began to be made to remedy the condition, innumerable new methods were devised, until finally we are now in a position to advise almost every sufferer from this condition, unless too old or suffering from some complication which would make it undesirable, to have a radical operation done. How little danger now attaches to the operation is seen in the fact that in a series of twenty-two hundred operations by Coley there have been only four deaths. Three of these occurred in the twelve hundred children; in the one thousand cases in adults, only one patient died — a mortality of only one tenth of one per cent. Well did Lord Lister at the Royal College of Surgeons on March 29, 1897, say of a similar

result: "An achievement like that is enough to cause gladness in the heart of any man who loves his fellow men."

All this is a result of the antiseptic method, which in turn is the result of animal experimentation.

Surgery of the Pituitary Body or Hypophysis

About at the crossing of two lines, one drawn horizontally backward between the eyebrows, and the other horizontally across between the temples, is a cup-shaped depression in the base of the skull a little smaller than the tip end of the little finger. In this is lodged a peculiar gland or body called the hypophysis or pituitary body. It is one of that strange class of "ductless glands" which exist in different parts of the body, among which are the thymus gland at the very lowest part of the neck in front; the thyroid gland, which when it becomes enlarged is called a goiter; the parathyroid bodies, three or four little bodies, each the size of a grain of wheat, situated behind the thyroid; the adrenal or suprarenal bodies at the upper end of each kidney, from which adrenalin is derived, and several other glands which have no tube or duct which can deliver their secretion into the circulation. The "internal secretions" which they are believed to produce, and which reach the blood current through the absorbents, formerly were thought to be of no importance, but now we know that these secretions, in some cases at least, are of supreme importance.

If in animals the pituitary gland is removed, death follows in the course of a short time. If all four of the little parathyroids are removed, death takes place before long. If all of the thyroid is removed, we have a condition which gradually develops into cretinism. In disease of the adrenal gland the skin becomes of a bronze color, etc., and disease of the thymus frequently results in sudden death. More-

over, the pancreas (which in animals we call the sweetbread) may be involved, and through that in turn the liver, so that this whole series of glands, small as most of them are, forms a most complicated system which we have only very recently begun to understand. What little we have learned has been chiefly by animal experimentation, and this little emphasizes the need for more and more knowledge, till we shall know thoroughly their functions, and what we can do to cure or, still better, to prevent their diseases.

This little gland, the pituitary body, though so very small, consists of a front and a back part, which are apparently wholly different in function. When an extract of the back part, which is supposed to be the most active, is injected into animals, it does harm, yet when the same part is entirely removed from the brain of an animal, no harm apparently results. The front half, however, has been found to be essential to life. Certain changes in the gland, if they arise in childhood, are followed by tremendous overgrowth of the body (gigantism), together with a deposit of much fat over the body. If the condition arises in an adult, there follows clumsy thickening of the hands, feet, features, etc. (acromegaly), and in other parts of the body an infantile condition is produced.

Surgery, it is astonishing to say, has dealt successfully with tumors of this small but important organ hidden in an almost inaccessible spot. In a few cases such tumors have been successfully removed in man with great relief, if not real cure of the symptons.[1]

Almost the same story may be told of all the other duct-

[1] A large number of operations have been done — one hundred and seven by Dr. Harvey Cushing alone with only eleven deaths, less than ten per cent (February, 1914). The results have been most encouraging, especially the restoration of sight, if the operation is not too long delayed. Strange to say, its extract or active principle has been found to be of the greatest value in childbirth — an unexpected boon. (See the *British Medical Journal*, April 25, 1904, p. 90.)

less glands which are so closely interrelated. Gradually, by experiment upon animals, we are learning what the functions of these important structures are, and by removal of parts or all of these glands, or by other experiments upon them, we are getting a glimmering knowledge of their interrelation, their importance, and the possibility of dealing with them medically and surgically. I believe that in the near future our ignorance about these various structures will be dispelled and the surgery of these glands will develop with rapid strides, greatly to the advantage of many patients.

Tetanus or Lockjaw

Among the many other subjects crowding upon me for description, I can only select one more — tetanus or lockjaw. In 1884, I remember my surprise and almost incredulity when I saw it asserted that Nicolaier, by experiments on mice, rabbits, and guinea-pigs, had discovered that the germ or bacillus of tetanus was found in the earth, and especially in that around stables and on highroads traveled by horses. It was such a novel idea that I was little inclined to accept this as a possible origin of lockjaw, but time has proved that Nicolaier was right. For many years we had known clinically that stablemen, above all others, suffered from lockjaw, but why this was so we did not understand. Now we know that this little microbe finds its chief abiding-place in and around stables, highroads, etc.

The popular belief that a wound from treading on a rusty nail is very likely to cause tetanus is quite correct. This is not because it is a nail or is rusty, but because by lying on the ground it has become infected with the germs of lockjaw. Moreover, as the punctured wound caused by the nail bleeds but little and this blood dries up and excludes the air, the most favorable conditions for the

development of tetanus exist, for, as Kitasato, the Japanese bacteriologist, proved, the absence of oxygen is most favorable to the growth of this germ.

The germ itself looks very much like a tack. So virulent is it that its toxin in doses of 1-200,000th of a teaspoonful will kill a mouse. It has been found by experiment that the poison is carried up to the spinal cord, not by the absorbents or the blood-vessels, as are other poisons, but through the motor nerves themselves. Fortunately, an anti-poison or antidote has been developed, but so prompt is the action of the poison that in an animal, two minutes after the injection of a fatal dose of the poison, twice as much of the remedy is required as if it had been administered with the poison; after eight minutes ten times the amount, and after ninety minutes forty times the original amount is necessary. This antitoxin is entirely harmless.

As a result of antiseptic methods lockjaw is now almost unknown except after neglected wounds, instead of being terribly frequent as it formerly was. When it is feared, the antitoxin is used as a preventive, and when it has developed, as a cure.

In animals — for naturally horses suffer enormously more frequently than man — the same antitoxin is used. In one hundred and sixty-three horses that had operations performed on them, but were protected by the antitoxin, not one developed tetanus, whereas of eight cases unprotected by the antitoxin, five developed tetanus. The result of all these experiments has been that what is known as "Fourth-of-July tetanus" has been enormously diminished, chiefly by the antitoxin used as a preventive.

It is well known now to every intelligent person that a large number of cases of tetanus develop from injuries, especially those received from toy pistols and blank cartridges in celebrating the Fourth of July. The following table from the "Journal of the American Medical Association" gives the number of persons injured, the number of

deaths, and the number of deaths from tetanus alone for several years past: —

Year	*Injured*	*Deaths (total)*	*Deaths from tetanus*
1903	4,449	466	406
1904	4,169	183	91
1905	5,176	182	87
1906	5,466	158	75
1907	4,413	164	62
1908	5,623	163	55
1909	5,307	215	125
Totals.....	34,603	1,531	901

The popular movement for a "sane Fourth of July" was begun by the doctors, and fortunately is spreading vigorously. Too long we have had an "insane" Fourth with its thousands of victims. Even the small Chinese "fire-cracker" has caused 10,781 serious injuries in the last seven years! [1]

[1] The splendid results of this campaign — conducted above all by doctors, mark you — is shown by the fact that the total number of injuries over the entire country, which was 5308 in 1896 was only 947 in 1912; and instead of 415 deaths from lockjaw alone in 1903 there were but seven in 1912 and 4 in 1913.

MODERN ANTISEPTIC SURGERY AND THE RÔLE OF EXPERIMENT IN ITS DISCOVERY AND DEVELOPMENT[1]

THE subject naturally divides itself into three parts: (1) the conditions before the introduction of the antiseptic method by Lister; (2) the means by which his system was discovered and developed, and (3) the conditions existing after the introduction of the method, i.e., at the present time.

My surgical life covers all three of these periods since I graduated in medicine in 1862, some years before Lister began his work. I have, therefore, fought my way from the horrors of the preantiseptic days up to the delights of the present antiseptic days.[2]

I. The Preantiseptic Period

In my early surgical experience every accidental wound and every surgical operation (that is, an intentional wound) was followed by inflammation and suppuration, i.e., the discharge of "pus" or "matter." This was not only constantly expected as an unavoidable process of nature and believed to be needful for healing, but was constantly realized. Hence the pus was called "laudable" pus! How well I remember forty years ago at the beginning of each winter's session when I was the assistant of the late Professor Samuel D. Gross, his turning to the orderly and saying to him, "To-morrow, Hugh, I shall lecture on

[1] Reprinted by permission of the Council in Defense of Medical Research of the American Medical Association. It is Pamphlet No. XII in their series. See list on p. XIX.

[2] In this article I use the word "antiseptic" as the more popular one to include also the aseptic method.

suppuration. Go over to the hospital in the morning and get a cupful of pus for my lecture." Pus, mark you, was always "on tap," so to speak, though the little hospital contained only a dozen beds!

Perhaps the best way to give the reader an idea of wound conditions at that time will be to describe an ordinary operation and its results. We will suppose that it is an amputation. The surgeon approached the operation with the clean hands of a gentleman. He usually wore an old coat covered with dried blood spots from previous service. His finger-nails very likely were long and no special attention was given to them. The instruments were taken out of a velvet-lined case and were as clean as ordinary table-knives would be. The operation was done without any preliminary cleansing of the skin other than to remove any visible dirt. If the knife happened to fall on the floor it was picked up, rinsed in a basin of ordinary water, and used as it was. The marine sponges then always used were washed clean in ordinary water and used over and over again even after being saturated with foul pus. The blood-vessels were tied with ordinary silk; one end was cut short, the other one hung out of the wound. After an amputation of a fleshy thigh I have often seen twenty-five or thirty such "ligatures," as they are called, gathered into two bundles, one at each end of the wound. The flaps were then sewed together with an ordinary needle and thread and the stump dressed first with an old rag (which, however, would be ordinarily clean) or scraped lint spread with some simple grease. Over that would be placed some other rags, lint, cotton, or other dressing, and finally a bandage. During the Civil War these greasy dressings gave place to simple cold-water dressings.

By the second day the patient would begin to have considerable fever. By the third or fourth the temperature would rise to what we now know (for medical thermometers were not in general use in that early day!) to about

103°, 104° or 105° F. Then we would poultice the wound. Every few hours the patient would be disturbed, a new poultice put on to replace the old one, now cold, foul and ill-smelling, and by this time bathed with pus. I have often seen the pus escaping by the tablespoonful and the wounds alive with squirming maggots resembling chestnut worms. By this time also it was hoped that the silk ligatures, with which the arteries had been tied, had literally "rotted" loose, and each one of them was gently pulled on to the discomfort of the patient. Care was taken that the ligatures with knots tied on them (in order to distinguish those that secured the large blood-vessels) should not be pulled on severely until probably the tenth or twelfth day. Meantime the patient was tossing about the bed with pain, with thirst, without appetite, without sleep except such as morphin would secure. This drug at the same time dried up all the secretions, producing constipation and other evils.

By about the tenth to the fourteenth day, suppuration having been fully established and quantities of pus pouring from the wound, the fever would subside and the wound would begin slowly to heal. Of course, the healing could not be complete so long as the silk ligatures were still protruding from the wound. Sometimes they did not become detached for even months or years, but more commonly all of them would rot loose in from ten days to three weeks. When the silk ligatures on the large blood-vessels came away, if the healing process had formed in the blood-vessels a firm clot, which had become adherent, and, so to speak, "corked" it up, all went well. But, as very frequently happened, when the ligature and the rotten end of the artery were pulled off and there was no clot to act as a stopper, "secondary[1] hemorrhage" followed. This often came on after the patient's wound had been dressed and the surgeon had left, and, if so, very likely the first

[1] So called to distinguish it from "primary hemorrhage," i.e., the bleeding occurring at time of the accident or operation.

notice that the nurse had that anything was wrong would either be the gasping for breath of the patient or his moans and cries, or sometimes by the blood which had not only saturated the mattress, but had even appeared in a pool on the floor. How fatal were such hemorrhages may be seen from the fact that in 2235 cases of hemorrhage in the Civil War 61.7 per cent of the patients died.[1]

I shall never forget one night about ten days after the battle of Gettysburg, when it was my business as "officer of the day" to attend to all emergency cases. That night I was called to five cases of secondary hemorrhage. To indicate what a difference there is between modern and ancient conditions, in the thirty-four years since October, 1876, when I began the practice of the antiseptic method, I have not seen as many cases of secondary hemorrhage as I treated in that one night.

It was a rare thing for any patient after such an operation to get well under three or four weeks, and it was not uncommon for healing to be delayed for three or four months, so that, in spite of the great mortality, the wards of the hospitals were cumbered with convalescent patients. The rare case in which healing took place by "first intention," i.e., at once, was recounted as a triumph. To-day it is precisely the reverse. The case in which healing does *not* occur primarily and at once is regarded as a disaster.

But a prolonged convalescence was the least of the evils to which a patient was subject. A large majority of the wounds were followed by erysipelas, by lockjaw, or by blood poisoning, and hospital gangrene sometimes became a veritable plague. Gangrene in various forms during the Civil War was rife and often fatal. In 2503 cases 1142 patients died, a mortality of 45.6 per cent.[2] In one variety which was frequent, hospital gangrene, a simple flesh

[1] *Med. and Surg. Hist. War of the Rebellion*, part III, Surg. vol., p. 765.
[2] *Ibid.*, p. 824.

wound scarcely larger than the bullet which made it, became larger and larger till a hand would scarcely cover it and it would eat into the tissues until one could put half his fist into the sloughing cavity.

Of 505 cases of lockjaw (tetanus), 451 were fatal, a mortality of 89.3 per cent.[1] Pyemia or blood poisoning was terribly frequent and almost as fatal as it was frequent, for of 2818 cases in the Civil War 2747 patients died, or 97.4 per cent![2] When a joint was opened or wounded, the result was frequently either amputation or death, or not uncommonly amputation and death. Of 2382 wounds of the knee-joint alone for which amputation was performed 1212 patients died, a mortality of 51 per cent, and of 973 similar wounds for which amputation was not performed 591, or 61 per cent, of the patients died.[3]

Fractures, as most people know, are divided into two kinds: simple fractures in which the skin is unbroken, and compound fractures in which the broken bone protrudes through the skin. Simple fractures nearly always heal with relatively little pain and slight fever; but in the preantiseptic days when the skin was broken and the bone protruded two out of three patients with these compound fractures were sure to die.

Moreover, certain regions of the body were forbidden ground unless the surgeon were absolutely compelled to invade them. No one would open the head if he could possibly avoid it. No one would dare to make an incision through the abdominal wall into the cavity of the abdomen unless a bullet or a dirk had gone before him and opened the way. The reason for our hesitation was that death stalked behind us.

How eloquent is the statement of Sir Samuel Wilks,[4] that "the change came home to me in an almost startling

[1] *Med. and Surg. Hist. War of the Rebellion*, part III, Surg. vol., p. 819.
[2] *Ibid.*, p. 858.
[3] *Ibid.*, p. 367.
[4] Royal Com. on Vivisection, 1907–08, Q. 7750.

manner from what I witnessed in the *post-mortem* room. Some time before [i.e., before Lister's discoveries], when reading a paper on pyemia [blood poisoning], I had no difficulty in collecting one hundred cases which had occurred within a very short time previously, when suddenly this terrible malady disappeared — it was gone never to return." So, too, lockjaw (tetanus), except in accidental cuts that have been neglected and have not received proper surgical care, has almost completely disappeared. Again, at the present day one practically never sees erysipelas after hospital operations; and in order to find illustrations of hospital gangrene to show to my classes for the last thirty years I have had to rely on pictures from the "Surgical History of the Civil War" and other similar sources, for I have not seen a single case in private or hospital practice since I first adopted the antiseptic method in 1876.

II. The Discovery and Development of the Antiseptic Method[1]

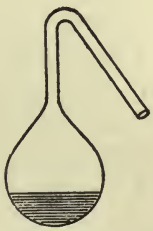
Neither time nor space will allow me to describe the many earlier steps. Schwann, in 1837, in studying putrefaction, reached the conclusion that it was not the gases of the air, especially the oxygen, as was then universally believed, that caused putrefaction, but organic particles which floated in the air and which could be destroyed by heat. In 1854 Schröder and Dusch showed that putrefaction did not occur in organic fluids in flasks if the air entering the flasks was simply filtered through cotton wool. Pasteur, in 1864, showed that it was necessary neither to heat the air nor thus to filter it, for if the air merely entered through a tortuous tube in which the dust could settle

[1] See Lord Lister's Collected Papers, Oxford, 1909 (later reference to these Collected Papers will be indicated simply by "Lister, vol. —, p.—"), the Lister number of the *Brit. Med. Jour.*, December 13, 1902. celebrating the fiftieth anniversary of his receiving his degree, Lister's "Huxley Lecture" in the same journal, October 6, 1900, and Cameron's "Lister and the Evolution of Wound Treatment, etc.," Glasgow, 1907.

before it reached the fluid no change took place in the fluid, or if flasks containing a material which would putrefy were left open in a place where the air had been undisturbed sufficiently long to allow the dust to settle, as, for example, in a cellar, no decomposition took place and no growth appeared in such fluids.

Lister naturally was profoundly impressed by these studies of Pasteur and he proceeded to make many experiments to confirm or disprove them. Among them I will only relate the following:[1] Lister filled four glass flasks one third full of urine and drew out the neck of each flask with a spirit lamp into a tube less than one twelfth of an inch in diameter. Three of these long open tubes were then bent at various angles downward, while the fourth, equally narrow, was left short and vertical. Each flask was then boiled for five minutes, after which they were left with the ends of the small necks still open. Through these open mouths the air, including its oxygen, would pass out during the heat of the day and pass in during the colder night. The boiling was to kill any organisms in the liquid or on the sides of the glass. The object of the bending of the three necks downward was to allow the air to pass in and out, but to intercept the particles of dust, which, according to the germ theory, caused putrefaction. The germs, being heavier than air, could not rise in the bent necks and reach the urine. The fourth neck, however, being short and vertical, not only allowed the air to pass in and out, but gave a very narrow but real opportunity

Flask with the open tube vertical.



Flask with the open tube bent downwards.

[1] Lister, vol. II, p. 173; *Brit. Med. Jour.*, 1871, vol. II, p. 225.

for dust and germs to fall into the liquid. If any of these were living organisms, they could produce putrefaction. In a short time the vessel with the short vertical neck showed growths of mold and the liquid changed its color, showing chemical changes; but in the three flasks with bent necks the urine *after four years was entirely unaltered.* A year after the commencement of the experiment a little of the urine in one of the flasks with a bent neck was poured into a wine-glass; it had not lost its original acidity and normal odor and a microscope showed not the minutest organism. In two days it was most offensive, and under the microscope already teemed with organisms. The three flasks with bent necks were subjected to a further severe and rather amusing test. Two years after the beginning of the experiment Lister had to transport them from Glasgow to Edinburgh on the railway when he was appointed to the chair of surgery in Edinburgh. He took charge of these flasks himself, "nursing them carefully," as he says, "to the amusement of my fellow travelers." In the drive from the station to his house the violent rocking of the carriage churned up the contents of the flasks till the upper part was full of a frothy mixture of this proved putrescible liquid with the atmospheric gases; yet after two years more no decomposition had taken place.

The explanation of this convincing experiment was simply this: The germs in the atmosphere could not rise against gravity in any of these tubes bent downward and so could not gain access to the urine. This easily preserved a decomposable fluid for four years, although the air passed in and out freely every day. But the urine in the flask with the straight but very narrow neck in a few days had undergone decomposition. The only difference between the flasks was that the three bent tubes prevented the entrance of the germs, though not of oxygen or other constituent of the air, while the straight but equally narrow tube allowed the germs to enter through in very

small quantities, and yet these few grew and produced putrefaction.

In order still further to confirm this experiment, however, Lister tested these bent tubes by the condensed beam of light which Tyndall had used and found that they were optically empty.[1]

These experiments convinced him that it was not the oxygen or any other gas in the air that caused inflammation and suppuration, but that these were caused by *minute organisms suspended in the air*. In dressing a wound, then, the problem was how to exclude not the air or its oxygen, which was impossible, but how to exclude the organisms in the air. This could be done by applying a dressing saturated with some material capable of destroying the life of these germs. This was the basis of the antiseptic method.[2] It must be remembered that at that time we were wholly ignorant of what now everybody knows, that there are hundreds of different kinds of germs or bacteria. Even the greatest scientists were then groping in the dark seeking for the light by observation and especially by experiment.

About that time Lister was much struck with an account of the effect of mingling phenol (carbolic acid) with the sewage of the town of Carlisle, England.[3] He proceeded, therefore, to experiment with it in compound fractures. I have already stated how fatal a compound fracture was in those days. Indeed, Mr. Syme, the great Edinburgh surgeon, predecessor and father-in-law of Lister, was inclined to think that, on the whole, "it would be better if in every case of compound fracture of the leg amputation were done without any attempt to save the limb." The marked success which followed Lister's dressing these

[1] See Tyndall's charming lecture on "Dust and Disease," in *Fragments of Science*, 1871, p. 275. D. Appleton & Co.

[2] Lister, vol. II, p. 37; *Brit. Med. Jour.*, 1867, vol. II, p. 246.

[3] Lister, vol. II, p. 3; *Lancet*, 1867, vol. I, pp. 326, 357, 387, 507, vol. II, p. 95.

compound fractures [1, 2] with carbolic acid led him then to experiment with its uses in abscesses.[1, 2, 3] This was followed again by such remarkable success that he was led to try it in accidental wounds and finally to intentional and extensive wounds, i.e., surgical operations.[4]

Practically the progressive introduction of the antiseptic system from compound fractures up to deliberate surgical operations was one vast experiment in the human living body — an experiment justified, as all the world well knows, by its splendid and continuing results. Yet when in 1880 or 1881 Lister wished to make additional experiments on animals to perfect his method still further, so stringent was the law in England that he was obliged to go to the Veterinary School at Toulouse, France.[5]

Like many surgeons, Lister had noticed the fact that a needle or a bit of glass would often lie for an indefinite period in the body without producing inflammation or pus, but that a bit of silk or linen thread was sure to produce pus. He believed the reason was that the thread was porous and that its interstices contained these germs which no one had then seen and identified, and that they gave rise to decomposition and produced the pus. So, Lister, from his previous experiments with phenol (carbolic acid) believed that if the thread with which an artery was tied were steeped in phenol and both the ends of the silk were cut short, it might be left in the wound without producing any inflammation or suppuration. The wound could then be closed at once — an immense gain, for it would heal at once. "Before applying these principles on the human

[1] Lister, vol. II, p. 3; *Lancet*, 1867, vol. I, pp. 326, 357, 387, 507; vol. II, p. 95.

[2] Lister, vol. II, pp. 3, 32, 37; *Brit. Med. Jour.*, 1867, vol. II, p. 246.

[3] Lister, vol. II, pp. 32, 36, 42; *Brit. Med. Jour.*, 1867, vol. II, p. 246.

[4] Lister, vol. II, pp. 188, 199, 256, etc.; *Brit. Med. Jour.*, 1871, vol. II, p. 225; *Edinburgh Med. Jour.*, 1871–72, vol. XVII, p. 144; *ibid.*, 1875–76, vol. XXI, pp. 193, 481.

[5] Lister, vol. II, p. 281; *Lancet*, 1881, vol. II, pp. 863, 901; *Trans. Internat. Med. Cong.*, London, 1881, vol. II, p. 369.

subject," he says, "I thought it right to test them on one of the lower animals."[1] Accordingly, December 12, 1867, he tied the great blood-vessel in the neck of a horse, having steeped the silk for some time in a solution of phenol. Both ends were cut short, the wound was entirely sewed up and treated with phenol dressings. Ten days after the operation the dressings were removed, the wound was healed, and there was no pus! Thirty-nine days after the operation he carefully examined the artery which he had tied. The operation was a complete success, the blood current had been entirely arrested and the thread had been covered in by dense fibrous tissue. "Thus encouraged," he says, "I felt justified in carrying a similar practice into human surgery."[2] January 29, 1868,[3] he saw a woman, fifty-one years old, with an aneurysm as large as a large orange in the upper part of the left thigh. (An aneurysm, I should explain, is a dilated portion of an artery, the yielding of the wall being due to disease of the wall of the blood-vessel. This dilatation continues to increase in size till finally the wall of the artery is so thin that it bursts and the patient dies from hemorrhage.) On the following day he tied the woman's artery with a piece of silk which had been steeped for two hours in phenol.

The wound was treated like that in the horse's neck, i.e., both ends of the ligature were cut short, the wound again entirely closed and a phenol dressing applied. The patient was immediately relieved of the pain she had previously experienced; she had no fever, the pulse was practically normal the entire time, and "her appetite, which had been absent during the four weeks of agony that preceded the operation, returned two days after it."[4] She made a perfect recovery. November 30, ten months after

[1] Lister, vol. II, p. 64; *Lancet*, 1867, vol. II, p. 668.
[2] Lister, vol. II, p. 65; *Lancet*, 1867, vol. II, p. 668.
[3] Lister, vol. II, p. 88; *Lancet*, 1869, vol. I, p. 451.
[4] Lister, vol. II, p. 89; *Lancet*, 1869, vol. I, p. 451.

the operation, she suddenly expired. Fortunately, Lister himself had the opportunity of making the *post mortem*. He found that her death was due to the bursting of a similar aneurysm inside of the chest. Examining the artery which he had tied, he found that the silk had almost all disappeared, but that there was a little fluid around the remnant of the ligature, which probably would have developed into a small abscess and might have caused great mischief had she lived longer. This, therefore, suggested to him the expediency of substituting for the silk some other substance which would be more readily absorbed.[1]

In Philadelphia, years before, Dr. Physick had already tried animal ligatures made of buckskin, Dorsey those of kid, Hartshorn had used parchment, and Bellenger and Eve the tendon of the deer, but for various reasons these had all been abandoned. Lister determined to try catgut. Although he had great confidence in the use of catgut steeped in a solution of phenol, yet he says[2] "in order to put the antiseptic animal ligature to the test, I made the following experiment," for only by experiment in an actual living body of animal or man could the question whether it was actually safe or not be surely answered. December 31, 1868, he tied the right carotid artery in the neck of a healthy calf at several places with different kinds of animal ligature, including catgut. All were cut short except one end of the catgut, which was purposely left three quarters of an inch long to determine what would become of this foreign material. The wound was completely closed and dressed. After ten days the dressings were removed and the wound found quite dry. Thirty days after the operation Lister says, on dissection, he was struck with the entire absence of any infection or inflammatory thickening in the vicinity of the blood-vessel. On exposing the artery itself he was greatly disappointed at

[1] Lister, vol. II, p. 89; *Lancet*, 1869, vol. I, p. 451.
[2] Lister, vol. II, p. 93; *Lancet*, 1869, vol. I, p. 451.

first to find the ligature to all appearance still there and as large as ever. On more careful examination, however, he found that this apparent ligature was not the catgut ligature at all, but that this ligature had been transformed into bands of living tissue, making the artery not weaker, as silk often did, but stronger than ever at the point where it was tied. The knots had disappeared and also the three-quarters inch of catgut purposely left. Everything had been absorbed.

Even one not a surgeon can see what an enormous difference in rapidity of healing without inflammation, pain or other serious disturbance of the body this use of catgut with immediate total closure and healing of the wound provided. Before Lister, the old ligatures hanging out in bundles were always inviting infection, suppuration, erysipelas, lockjaw, blood poisoning, hospital gangrene and death. No patient was absolutely safe till the wound was absolutely healed and this often required weeks or months. With the catgut ligature, both ends being cut short, the wound closed at once, and, the ligature being absorbed, the wound healed in less than a week, not uncommonly in three or four days, with little, if any, immediate suffering and without any ultimate danger of those many serious complications above mentioned. But no one not a surgeon can appreciate to the full the meaning of these brief words. While the patient made a smooth and speedy recovery without complications, the surgeon slept the uninterrupted sleep of the just, secure against wearing anxiety on account of sudden hemorrhage or insidious infection. The heart-breaking tragedies which often made the surgeon wish he were a hod-carrier or even in his grave are now but specters of a horrid past.

As I have said, we had no idea at first of the enormous variety and different characters of the germs. In his early studies on putrefaction, Lister spoke of them in a general way as "germs," because the various species of plants (for

they are plants and not animalculæ) had not been distinguished. Now there are scores and even hundreds of known varieties. Many of these simply cause putrefaction or decomposition and are not in themselves capable of giving origin to any particular disease. Other varieties, each one of which causes a special disease and can cause no other disease, have been isolated and identified. Some of these germs cause medical diseases, with which I have nothing to do here. The germs of lockjaw, tuberculosis, anthrax (wool sorters' disease), erysipelas, glanders, etc., are among the most virulent foes with which the surgeon has to contend.

How have these been identified and how do we prevent their entrance into the system of the patient? The process is very simple to describe, but very complicated and difficult practically. Let us take the case of lockjaw for instance. A peculiar kind of germ, looking a good deal like a tack with a straight body and a large head at one end, was discovered by animal experiments by Nicolaier in earth and dust in 1884.[1] In 1889 Kitasato, the Japanese bacteriologist,[2] first obtained it in pure culture (i.e., free from all other germs), former experimenters having failed because they did not know that it only grows well when oxygen is excluded.

But how do we *know* that this tack-like germ and it alone is the cause of lockjaw?

First, in a patient ill with lockjaw, this particular bacillus or germ must be discovered.

Second, a pure culture of it must be produced; that is to say, the tetanus bacillus must be separated from all other germs and cultivated by itself.

Third, some of this pure culture of tetanus unmixed with any other germs whatever must be injected into an animal to see point-blank whether this particular bacillus will produce lockjaw.

[1] *Deutsch. med. Wock.*, 1884, no. 52, p. 842. [2] *Ibid.*, 1889, no. 31.

Fourth, from the body of this animal the same germ that was injected must be recovered.

Fifth, with a pure culture of this recovered bacillus the cycle must be begun over again and completed sufficiently frequently to assure the experimenter that the connection between the disease and the germ is not accidental, but essential and invariable.

Sixth, no other germ used in the same way must produce lockjaw.

In this same manner the germs that produce inflammation and suppuration, which are *the* ever-present danger to the surgeon, have been identified, and also, what is equally important, the places where they and many others exist. In this way we have determined the fact that, while there are some in the air, they are few in number and so constitute a small though a real danger. But the places where they are found and are most dangerous are on the skin and clothing of the patient, the hands of the surgeon and especially under his finger nails and at the roots of his finger nails, on instruments, dressings, silk, catgut, and other things used for ligatures; in fact, practically every material that one can think of. We know now how all-pervading they are. We know, too, that phenol (carbolic acid), corrosive sublimate and other chemicals, or that boiling for a certain time, or heating to a certain degree and for a certain time, will kill these germs. Thousands of such painstaking researches in test-tubes and by many other bacteriologic methods have been carried out all over the world by men either wholly unpaid, working for the love of truth and love of their fellow creatures, or paid but meager pittances. Then when a discovery seems to have been made comes the needful, the finally convincing, the unavoidable experiment—in a living body itself. The only question is should Lister have made this final test first on a horse and a calf, or on two human beings? Can any one with a sane, well-balanced mind hesitate as to the answer?

III. The Results

The results of the establishment of the antiseptic method have been so extraordinary as to be incredible were it not for ample testimony the world over. They have been already stated in part, but a few words more must be added.

At present before an operation is begun the patient's skin, the surgeons' and the nurses' hands are scrupulously disinfected, sterile gloves are usually worn and every person is clothed in a disinfected gown. The instruments, dressings, ligatures, everything that is to come in contact with the wound, is carefully disinfected. Disinfected gauge "sponges" are used once and then discarded.

It is almost impossible for any one not a surgeon to understand how different are the results from this radical change of methods. No change of climate from fierce midwinter storms to lovely summer breezes or autumn golden harvest could be greater. Most wounds now heal within a few days, often one might almost say without the patient's being sick. Compound fractures and opened joints heal as if there had been no break in the skin. Arteries can be tied anywhere without fear of secondary hemorrhage. The abdomen is now fearlessly opened.

A woman with an ovarian tumor no longer has an operation postponed until it is very dangerous but inevitable, but by early operation is relieved almost without danger, even from tumors so large as to weigh twice as much as the patient herself. When I was assistant to Dr. Washington Atlee in the late sixties, before the antiseptic period, two out of three of his ovariotomy patients died, yet he was the then most famous operator in America. Now any surgeon who loses more than five out of one hundred is looked at askance by his colleagues, and many, many hundreds of cases have been operated on with a mortality falling even below one per cent. There is not an organ in the abdomen

that has not been attacked; organs which formerly when diseased could not be touched because death was almost sure to follow are now operated on every day. In fact as I once described it, the abdominal cavity is almost the surgeon's playground! The stomach, the intestines, the liver, the gall bladder, the pancreas, the spleen, the kidney, every organ is operated on, and with extraordinary success. Did space permit, a more detailed statement could be given, but it could scarcely be more convincing.

In obstetrics the same happy results have followed the introduction of the antiseptic method. Puerperal or "childbed" fever, which not uncommonly used to kill one half or two thirds or even three fourths of the women in the maternity wards of a hospital, now is practically unknown except in the neglected cases brought into the hospital at a late date, and the pre-antiseptic general mortality in maternity cases has been reduced from ten per cent or more to one per cent and less. Brain tumors, abscesses and other diseases of the brain formerly inevitably caused death, for we never dared to touch them. Now the number of recoveries is very large. Compound fractures now have a mortality of two or one per cent or less, instead of over sixty per cent, and now very rarely require amputation; and amputations formerly followed by death in one half the cases have a mortality of ten per cent or less. In general, both the soldier and the sailor are provided with the first-aid packet, which contains an antiseptic dressing. This has enormously diminished the mortality of wounds received in battle.

Perhaps no better evidence of the value of the antiseptic method in civil life can be adduced than the results in three hospitals. In Munich[1] the General Hospital was excessively unhealthy. Blood poisoning was very frequent and hospital gangrene, which had appeared in 1872, had become annually a more and more frightful scourge until

[1] Lister, vol. II, p. 248; *Brit. Med. Jour.*, 1875, vol. II, p. 769.

1874, when *eighty per cent* of all wounds that occurred in the hospital, whether accidental or inflicted by the surgeon, were attacked by it! At the beginning of 1875 Nussbaum introduced the antiseptic treatment. From then on till Lister's visit, presumably in the summer of 1875, *not one single case* of hospital gangrene had occurred and only one case of blood poisoning, and that a doubtful one. Erysipelas was rare and mild instead of being very prevalent and severe, and the convalescent wards, which formerly had been filled to overflowing, stood practically empty. In Halle,[1] Volkmann was operating in an extremely unhealthy hospital in small, overcrowded wards, with the toilet rooms opening directly into them and a large drain running directly underneath. It was so bad that it had been condemned to demolition. After his introduction of the antiseptic method in 1872, no single patient suffering from compound fracture in which conservative treatment was attained had died either from the fracture or from a necessary amputation, nor was there a single death from secondary hemorrhage or gangrene. No case of blood poisoning had occurred for a year and a half, though sixty amputations had been done. Hospital gangrene had entirely disappeared and erysipelas was extremely rare and mild.

Perhaps, however, the most extraordinary success was obtained by Lister[2] in his own wards in Glasgow. Lister was professor of surgery in Glasgow from March, 1865, till the autumn of 1869, but in that brief period he introduced measures that were absolutely revolutionary. The Royal Hospital in Glasgow was overcrowded, and in some parts of the building the conditions were so frightful that the wards had to be entirely shut up for a time. Lister's own account of this is interesting. He says: —

> A crisis of this kind occurred rather more than two years ago in the other male accident ward on the ground floor, separated

[1] Lister, vol. II, p. 250; *Brit. Med. Jour.*, 1875, vol. II, p. 769.

[2] Lister, vol. II, p. 124; *Lancet*, 1870, vol. I, pp. 4, 40.

from mine merely by a passage twelve feet broad, where the mortality became so excessive as to lead, not only to closing the ward, but to an investigation into the cause of the evil, which was presumed to be some foul drain. An excavation made with this view disclosed a state of things which seemed to explain sufficiently the unhealthiness that had so long remained a mystery. A few inches below the surface of the ground, on a level with the floors of the two lowest male accident wards, with only the basement area, four feet wide, intervening, was found the uppermost tier of a multitude of coffins, which had been placed there at the time of the cholera epidemic of 1849, the corpses having undergone so little change in the interval that the clothes they had on at the time of their hurried burial were plainly distinguishable. The wonder now was, not that these wards on the ground floor had been unhealthy, but that they had not been absolutely pestilential. Yet at the very time when this shocking disclosure was being made, I was able to state, in an address which I delivered to the meeting of the British Medical Association in Dublin,[1] that during the previous nine months, in which the antiseptic system had been fairly in operation in my wards, not a single case of pyemia [blood poisoning], erysipelas, or hospital gangrene had occurred in them; and this, be it remembered, not only in the presence of conditions likely to be pernicious, but at a time when the unhealthiness of other parts of the same building was attracting the serious and anxious attention of the managers. Supposing it justifiable to institute an experiment on such a subject, it would be hardly possible to devise one more conclusive.

Having discovered this monstrous evil, the managers at once did all in their power to correct it. . . . But besides having along one of its sides the place of sepulture above alluded to, one end of the building is coterminous with the old cathedral churchyard, . . . in which the system of "pit burial" of paupers has hitherto prevailed. I saw one of the pits some time since. . . . The pit, which was standing open for the reception of the next corpse, emitted a horrid stench on the removal of some loose boards from its mouth. Its walls were formed on three sides of coffins piled one upon another in four tiers, with the lateral interstices between them filled with human bones, the coffins reaching up to within a few inches of the surface of the ground. This was in a place immediately adjoining the patients' airing ground, and a few yards only from the windows of the surgical wards! And the pit which I inspected seems to have been only one of many similar recep-

[1] Lister, vol. II, p. 45.

tacles, for the "Lancet" of September 25 contains a statement, copied from one of the Glasgow newspapers, that "the Dean of Guild is said to have computed that five thousand bodies were lying in pits, holding eighty each, in a state of decomposition, around the infirmary."

When to all this is added the fact that the large fever hospital was separated from the surgical hospital by only eight feet, that Lister's hospital of nearly six hundred beds was cramped in area and almost always full to overflowing, and that he was operating, it might almost be said, in a charnal house, yet that those wards were continuously and conspicuously healthy and enjoyed for "three years immunity from the ordinary evils of surgical hospitals under circumstances which but for the antiseptic system were specially calculated to produce them," [1] we stand convinced by such a huge unintentional experiment on man himself.

Were not results such as these sufficient to justify the experiments on animals as related by Lister himself and here quoted, by which such blessed relief has been brought to mankind?

What was seen in Glasgow has occurred all over the world. The surgical revolution of the last thirty years is the most momentous in the entire history of surgery. In every science — chemistry, engineering, botany, physics, electricity — the era of precise *experiments* has been the era when enormous and constant progress has been made. Medicine is no exception. We have closely studied disease by various observational methods, and clinical observation for two thousand years had slowly advanced our knowledge up to a certain point. Then experimental research, which employed methods of precision, varying conditions at will, noting the different results, and multiplying the experiments at will instead of waiting, it might even be years, until Nature's second experiment occurred,

[1] Lister, vol. II, p. 126; *Lancet*, 1870, vol. I, pp. 4, 40.

began its work; and in the past thirty years experimental research has produced a more fruitful harvest of good to animals and to mankind than the clinical observation during thirty preceding centuries.

But we are far from having attained perfection. In medicine and in surgery many problems of disease and death are still awaiting solution and can only be solved by the experimental method. A number of organs in the body are as yet inaccessible and others have functions of which we know little or nothing. Many operations ought to be bettered in method and in results. The cause of many diseases, such as cancer, scarlet fever, measles, whooping-cough, etc., are as yet unknown. To dispel all this ignorance and discover a cure for all these and other diseases is the earnest wish of wise and humane experimenters the world over. Shall the community aid these humane life-saving efforts, or shall they by restrictive legislation call a halt and let death slay our fellow creatures and especially our dear children? The answer is clear. It will never be other than an emphatic NO to the latter cruel course.

WHAT VIVISECTION HAS DONE FOR HUMANITY[1]

In 1905 I had made all my arrangements to do an operation on a Thursday morning. Among my assistants was Dr. C. On Wednesday morning he telephoned and said he was not feeling very well and that I had better engage some one to take his place. This I did, giving no special thought to the matter, supposing it was an unimportant passing illness. At ten o'clock that same night I was startled by a telephone message that if I wished to see Dr. C. alive I must come at once! In a few minutes I was there, but he was already unconscious. As I sat beside him and his weeping young wife, who soon expected to become a mother, how I longed for some means by which the hand of death could be stayed; but he died in less than thirty-six hours from the time that he was seized with epidemic cerebro-spinal meningitis.

On June 16, 1909, Charles E. Hughes, Jr., son of the Governor of New York State, and president of his class, was graduated at Brown University. A few weeks earlier he had been suddenly seized with a violent attack of the same disease — epidemic cerebro-spinal meningitis. When some of the fluid around his spinal cord was removed by "lumbar puncture" — that is, puncture of the spinal canal in the small of the back by a hypodermic needle — there settled to the bottom of the test-tube a half inch of pure pus ("matter"). No medical man familiar with this terrible disease would have thought it possible that he could recover when such a condition existed. But in 1907,

[1] Reprinted, by permission from the *Ladies' Home Journal*, April, 1910, and of the Council on Defense of Medical Research of the American Medical Association. It is Pamphlet no. XIV in their series. (See p. xix.)

midway between the death of Dr. C. and the case of young Hughes, Drs. Flexner and Jobling, of the Rockefeller Institute, had discovered by researches on animals alone a serum against this disease. Three doses of this serum were administered also by "lumbar puncture" to young Hughes. Within twenty-four hours after the first dose his temperature fell to normal. The pus disappeared after the second dose and he soon recovered and was able to take his degree in the presence of his proud father. The tragedy in the case of Dr. C. was averted, a useful life was spared, and a family made happy.

In discovering this serum Dr. Flexner experimented on twenty-five monkeys and one hundred guinea-pigs. Many of these animals themselves had been cured by the use of the serum. Having, therefore, found it effective in animals he proceeded to test it on human beings. Before the introduction of the serum, medicine was almost helpless. Whatever treatment was adopted seventy-five to ninety patients out of one hundred were sure to die. In two years this serum has been used in this country and in Europe in about one thousand cases. In these one thousand cases the mortality has dropped, in different series each under the care of the reporter, to thirty, twenty, ten, and even to seven in a hundred. If we take the mortality of the days before the serum treatment was used at seventy-five per cent, and the mortality since it was discovered, say, at twenty-five per cent, there is a clear saving of five hundred human lives! Not only have five hundred human lives been saved in these first one thousand cases, but for all time to come in every thousand five hundred more human lives will be saved.

Moreover, we must not forget that these thousands who would die were it not for Dr. Flexner's serum had families and friends who would have been filled with sorrow, and, in case it was the bread-winner of the family whose life was lost, would have had to suffer the depriva-

tions and pangs of poverty and the community have had to assume their support.

Let me now put a plain, straightforward, common-sense question. Which was the more cruel: Doctor Flexner and his assistants who operated on twenty-five monkeys and one hundred guinea-pigs with the pure and holy purpose of finding an antidote to a deadly disease and with the result of saving hundreds, and, in the future, of thousands on thousands of human lives; or the women who were "fanned into fury" in their opposition to all experiments on living animals at the Rockefeller Institute, "no matter how great the anticipated benefit"?

If these misguided women had had their way, they would have nailed up the doors of the Rockefeller Institute, would have prevented these experiments on one hundred and twenty-five animals, and by doing so would have ruthlessly condemned to death for all future time five hundred human beings in every one thousand attacked by cerebro-spinal meningitis!

If your son or daughter falls ill with this disease, to whom will *you* turn for help — to Flexner or to the anti-vivisectionists?

Of these one hundred and twenty-five animals, as a rule those which died became unconscious in the course of a few hours and remained so for a few hours more till they died. They suffered but little. When they died they left no mourning families and friends. They left undone no deeds of service or of heroism to either their fellows or to the human race, as the human beings whose lives were rescued by their death may do. But these deluded women had their minds so centered on the sufferings of these one hundred and twenty-five animals that their ears were deaf and their hearts steeled against the woes and the sufferings of thousands of human beings, their families, and their friends. Is this common sense? Are not human beings "of more value than many sparrows"?

Less than two years ago their first baby was born to a young doctor and his wife in New York City. Scarcely was the child born before it began to bleed from the nose, the mouth, the gums, the stomach, and the bowels. It was a case which we know as "hemorrhage of the newborn," which attacks about one baby in every thousand. It is very frequently fatal, and in treating it up to that time physicians practically groped in the dark, trying one remedy after another, but, alas, too often in vain!

The bleeding continued. This poor little baby soon showed the pallor which accompanies severe loss of blood. It lost all appetite, was suffering from high fever, and, finally, by the fourth day the physician in attendance told the parents frankly that the child could live only a few hours. Then, in the dead of the night, the father wakened Dr. Carrel, one of the assistants in the Rockefeller Institute. The father lay down alongside of his firstborn. The artery of the pulse in the father's arm was laid bare and sewed end-to-end to a vein in his baby's leg, and the blood was allowed to flow from father to child. The result was most dramatic. A few minutes after the blood began to flow into the baby's veins, its white, transparent skin assumed the ruddy glow of health, the hemorrhage from every part of the body ceased instantly and never returned, and, as Dr. Samuel Lambert, who reports the case, puts it, there was no period of convalescence; immediately before the operation the baby was dying; immediately after the operation it was well and strong and feeding with avidity. That baby to-day, after two years, as I know personally, is a splendid specimen of a healthy child.

Perhaps my readers may see nothing very wonderful in this, but we surgeons know that it is one of the most remarkable recent achievements in surgery. For many years we have been trying to devise a method by which we could sew severed blood-vessels end-to-end without danger to the patient. The difficulty has always been

that, no matter what were the methods employed, the blood nearly always formed clots at the roughened ring where the two ends of the divided blood-vessels were sewed together. These clots passed up to the heart and into the lungs of the patient and produced pneumonia, so that the old method of transfusion of blood has been practically abandoned for years. Dr. Carrel worked out his new method on the blood-vessels of dead human beings, and, when it seemed to him to be satisfactory, put it to the proof on two living dogs, and then used it in living human beings. It is now in use everywhere.

Moreover, Dr. Crile, of Cleveland, who has so splendidly enlarged our means of coping with disease, has used the same method in another way. When patients come to him too weak to be operated on and ordinary tonics and food do not strengthen them, he has transfused the blood from husband, father or son, and thus given the patient sufficient strength to bear the operation. He has used even a more striking method. For example when a woman has to be operated on — say for cancer of the breast — and is so weak that the shock, the anesthetic and the loss of blood would probably turn the scale against her, he has had the husband lie down alongside of her, has sewed the artery of the pulse of the husband to a vein in his wife's leg and allowed the blood to flow. In a few minutes, when she has become strong enough, he has etherized her and proceeded with the operation, starting or stopping the flow of blood according to the varying needs of the patient. At the end of the operation, through the new life-blood that has been given her, the patient has been in better condition than when the operation began. These methods, too, are now in successful use by other surgeons.

Let me again put the plain, straightforward, common-sense question: Who is the more cruel: Dr. Carrel, in devising this life-saving method of transfusion of blood by experimenting on two living dogs, and saving through

himself and other surgeons scores of lives already, and even thousands in the future; or the women who would shackle him, shut up the Rockefeller Institute and thrust these poor patients into their graves? Does not the work of Drs. Flexner, Jobling and Carrel and their assistants not only justify the existence of the Rockefeller Institute, but also bid us tell them Godspeed in their mission of mercy, and give them and those engaged in similar blessed work all over the world our confidence, encouragement and aid? Is it just, is it fair, is it Christian to call such an institution a "hell at close range," as the Rockefeller Institute is called in a pamphlet written by a woman and distributed by anti-vivisectionists?

I suppose that in this day of general intelligence scarcely any person, obliged to submit to an operation, would be willing to have it done by a surgeon who did not use antiseptic methods. These methods we owe to Lord Lister, of London, still living in his eighty-third year. Few of my readers, however, know how enormous the contrast is between the days before Lister's discoveries and the present. I was graduated in medicine in 1862. The antiseptic method was adopted by various surgeons, we may say roughly, between the years 1875 and 1880. Prior to 1876 I practiced the old surgery, but ever since then the new antiseptic method. I passed through the horrible surgery of the Civil War, when blood poisoning, erysipelas, lockjaw, hospital gangrene, and all the other fearful septic conditions were everyday affairs. In five hundred and five cases of lackjaw during the Civil War four hundred and fifty-one patients died. In wounds of the intestines the mortality was ninety-nine out of a hundred. In sixty-six cases of amputation at the hip-joint, fifty-five patients died. In one hundred and fifty-five cases of trephining, ninety-five patients died. After the war for some years I was an assistant of Dr. Washington L. Atlee. A more careful surgeon I never saw, but two out of every three of

his patients died. There are now many surgeons who can show series of hundreds and even thousands of cases of ovariotomy and other abdominal operations with a mortality of only five in a hundred, and some of only one in a hundred. After "clean" operations — that is, with no "matter" present — blood poisoning, lockjaw, and erysipelas are well-nigh unknown, and I have not seen a single case of hospital gangrene in the thirty-five years since I adopted the antiseptic method.

One of the most common operations is amputation of the breast for cancer, in which now we do far more extensive operations than formerly. These operations are followed by permanent cure in more than one half of the patients operated on early, and rarely more than one or two women in every hundred die. Recovery also follows in a few days and not seldom with but little pain, instead of several weeks or even months of great suffering as before the days of antisepsis.

All of this wonderful improvement we owe to Lord Lister and the new science of bacteriology which treats of "bacteria" or "germs." Both Lister's work and that of the bacteriologist are and must be absolutely founded finally on experiments on animals. The laboratory was of use, but, in order to be absolutely certain that he was right he had to experiment on a few animals — the only possible way of achieving positive knowledge.[1]

Who, I ask, are the more humane: Lord Lister and other surgeons who have made these life-giving, pain-saving experiments on animals, or those who — if they had succeeded in the past in prohibiting such experiments — would have compelled surgeons in 1910 to continue to use the same old, horrible, dirty methods of surgery as in the days before Lister, and thus to offer up hecatombs of human lives to the Moloch of antivivisection? Which

[1] For an account of how Lister discovered and developed his antiseptic method see the next preceding paper, p. 199.

method will any man of common sense or any woman with a human heart choose?

Even in surgery it is doubtful if a more wonderful improvement has been realized than in our maternity hospitals and in private obstetric practice as a direct result of the work of Pasteur and Lister. Well do I remember as a young man every now and then an outbreak of that frightful and fatal puerperal or "childbed" fever in our maternity hospitals. Almost every woman who then entered such a hospital was doomed to suffer an attack of the fever, and its mortality sometimes ran up to seventy-five, or even more, out of every hundred mothers. Often such hospitals had to be closed till the then unknown poison disappeared. Not a few obstetricians had to quit practice entirely for weeks because every woman they attended fell ill of the disease and many, many died. Finally Pasteur appeared on the field. In 1879, in a discussion on puerperal fever at the Paris Academy of Medicine, after a member had eloquently discussed various alleged causes of these epidemics, Pasteur interrupted him and said: "All this has nothing to do with the cause of these epidemics. It is the doctors who transport the microbe from a sick woman to a healthy woman." When the speaker responded that he feared they would never find this microbe, Pasteur immediately advanced to the blackboard, drew the picture of what we know as the "streptococcus" and said: "This is the cause of the disease." This recognition of the streptococcus as the cause of puerperal fever and the consequent adoption of antiseptic methods have practically abolished puerperal fever and reduced the mortality in maternity cases to less than one in a hundred.[1]

All this we owe absolutely to experiment on animals. Nothing else could have given us the knowledge. Even the horrible experiments that were being made by doctors

[1] For a fuller account of the results in childbed fever see the paper on "The Influence of Antivivisection on Character," *post*, p. 256.

who were ignorantly spreading the poison all around them, even these were not sufficient to open our eyes to the real cause of the disease. The laboratory test-tubes and experiments on animals were the chief means by which this scourge of motherhood has been banished.

In addition to all these, another fearful disease, yellow fever, has also been abolished by experiment which was necessary for the final convincing proof. I need not repeat at length the frightful ravages of this terrible pestilence in days gone by. Cuba was never free from it for nearly two centuries until the American Commission showed how to get rid of it. The Panama Canal Zone had perhaps the worst reputation in the world as a graveyard for strangers, and now for four years not a single case of yellow fever has originated there! Colonel Gorgas has made the Panama Canal a possibility.

I wish that every one might read that most interesting little book, "Walter Reed and Yellow Fever," by Dr. Howard A. Kelly, and see the wonderful methods by which this scourge of humanity has been abolished. When one thinks of the enormous difficulties of the problem, the wonder is that it was ever solved. There are about four hundred varieties of mosquito. Only one of them carries the poison of yellow fever. Of this variety only the female carries the poison, and this female mosquito must have bitten a patient sick with yellow fever during the first three days of his illness, or she could not become infected. Moreover, after infection, the poison, whatever it is, does not develop in the body of the female mosquito for about twelve days. Some of these facts were thought to be true, but there was no positive proof. A very large number, perhaps the majority, of yellow-fever experts still believed that the disease was carried in clothing, bedding, etc. To disprove this experiments were tried first of all by doctors on themselves. They slept in the beds in which yellow-fever patients had died, and in their very clothes, night

after night — clothes soiled with their black vomit, urine, and feces. At other times doctors have actually swallowed the black vomit, tried to inoculate themselves by putting some of it into their eyes, by hypodermic injections, etc., in the vain attempt to discover the cause of the disease and the means by which it was spread, hoping in this way to discover the means of preventing it. Surely self-sacrifice could go no farther. Yes, it could go farther. One more step was requisite. The only way to give the absolute final proof was for a well man to be bitten by a mosquito known to be infected. Dr. Carroll, of the United States Army, was the first one who offered himself. Other men followed — doctors, soldiers, and others. Several lost their lives, among them Dr. Lazear at the beginning of a most promising career. His tablet in the Johns Hopkins Hospital, in the fine words written by President Eliot, records that "With more than the courage and the devotion of the soldier he risked and lost his life to show how a fearful pestilence is communicated and how its ravages may be prevented."

It is often said that such experimental work brutalizes men. Let us read a letter from Dr. Reed to his wife, remembering, also, that the same high and holy purposes animate Drs. Flexner, Carrel, Crile, and other experimenters: —

QUEMADO, CUBA,
11.50 P.M., December 31, 1900.

Only ten minutes of the old century remain. Here have I been sitting, reading that most wonderful book, "LaRoche on Yellow Fever," written in 1853. Forty-seven years later it has been permitted to me and my assistants to lift the impenetrable veil that has surrounded the causation of this most wonderful, dreadful pest of humanity and to put it on a rational and scientific basis. I thank God that this had been accomplished during the latter days of the old century. May its cure be wrought out in the early days of the new! The prayer that has been mine for twenty years, that I might be permitted in some way or at some time to do something to alleviate human suffering, has been granted!

This prayer of Reed — that its cure might be wrought out in the new, the twentieth century — has been abundantly realized and yellow fever is now a vanquished foe.

Unfortunately, the lower animals cannot be infected with yellow fever. If they could be, Lazear and the other victims would have been saved. But they, yielding up their lives as leaders of a forlorn hope in the battle against disease, have made it possible to free the world from this dreadful scourge. Never was there a finer exhibition of courage!

The antivivisectionists have never dared to attack these experiments upon man. If they had dared to do so, public opinion would have made short work of them.

A few years ago I was called to Annapolis to see a young man who had been injured in a football game. He was evidently swiftly going to his grave. He had certain peculiar symptoms, which, in the light of cerebral localization — that is, the fact that certain definite portions of the surface of the brain have each a certain definite function — I believed to be due to a clot of blood inside of his head above his left ear. There was a bruise, not above the ear, but at the outer end of the left eyebrow. Before 1885 I should have opened his skull under the bruise, — apparently the almost certain point of injury, — would have failed to find the clot, and he would surely have died. Instead of this I made a trap-door opening three inches away from this bruise, removed nine tablespoonfuls of clotted blood, closed the wound so that his skull was as firm as ever, and he recovered, continued his studies, was graduated from the Naval Academy. Lately he has heroically given up his life at the call of duty. Had it not been for experiments on animals which had definitely fixed certain spots in the brain as the centers for movements of the hand, arm, shoulder, head, face, etc., it would have been utterly impossible for me to save his life. This is but one of hundreds of similar cases in which modern surgery

deals with tumors of the brain, hemorrhage inside of the skull and many other disorders, and deals with them successfully.[1]

I have heard the following pitiful story from one of my colleagues. He and a young mother stood by the bedside of her only child. The child, in the throes of diphtheria, was clutching at its throat and gasping vainly for breath. Suddenly the mother flung herself on the floor at the doctor's feet in an agony of tears, entreating him to save her child. But alas! it was impossible. Had this case occurred a few years later, however, when the blessed antitoxin for diphtheria had been discovered (solely by animal experimentation), this remedy would have been given early; and almost certainly within a few hours the membrane would have softened and disappeared, and that life, precious beyond rubies, might have been saved.

In those early dreadful days the only comfort we could give such distracted mothers — possibly some of them may read these very lines — was that "it was God's will." Yes! Then, possibly, it was God's will; but now, thank God, it is not His will. One might as well say it is God's will that thousands should die from smallpox when vaccination will protect them; that other thousands should die from typhoid fever when a pure water-supply and the banishment of the fly will prevent it; that thousands of women should die from puerperal fever when sterile hands and sterile instruments will save them!

Let me give a table of some official reports showing in nineteen American and European cities the mortality in every one hundred thousand inhabitants from diphtheria in 1894 — that is to say, before the use of the antitoxin of diphtheria — and in 1905, when its use had become general. Being official and from nineteen cities in America and Europe, its accuracy can hardly be assailed.

[1] See "Midshipman Aiken and Vivisection," *ante*, p. 146, for a fuller account of this case.

Table of Mortality from Diphtheria

	Per 100,000 *Inhabitants*	
	1894	1905
New York	158	38
Philadelphia	128	32
Baltimore	50	20
Boston	180	22
Brooklyn	173	43
Pittsburg	64	26
London	66	12.2
Paris	40	6
Vienna	114	19

These nine and ten other large cities taken together average as follows; in 1894, 79.9, and in 1905, 19, per 100,000 inhabitants — that is to say, in these nineteen cities the average death-rate in 1905 was less than one fourth of the rate before the introduction of the serum treatment.

The alleged atrocities so vividly described in antivivisection literature are fine instances of "yellow journalism," and the quotations from medical men are often misleading. Thus, Sir Frederick Treves, the eminent English surgeon, is quoted as an opponent of vivisection in general. In spite of a denial published seven years ago, the quotation still does frequent duty. I know personally and intimately Horsley, Ferrier, Carrel, Flexner, Crile, Cushing and others, and I do not know men who are kinder and more lovable. That they would be guilty of deliberate cruelty I would no more believe than that my own brother would have been.

Moreover, I have seen their experiments, and can vouch personally for the fact that they give to these animals exactly the same care that I do to a human being. Were it otherwise their experiments would fail and utterly discredit them. Whenever an operation would be painful an anesthetic is always given. This is dictated not only by humanity, but by two other valid considerations: first,

long and delicate operations cannot be done properly on a struggling, fighting animal any more than they could be done on a struggling fighting human being, and so again their experiments would be failures; and second, should any one try an experiment without giving ether he would soon discover that dogs have teeth and cats have claws. Moreover, it will surprise many of my readers to learn that of the total number of experiments done in one year in England ninety-seven per cent were hypodermic injections and only three per cent could be called painful!

If any one will read the report of the recent British Royal Commission on Vivisection, "he would find," says Lord Cromer, "that there was not a single case of extreme and unnecessary cruelty brought forward by the Antivivisection Society which did not hopelessly break down under cross-examination."[1]

In view of what I have written above — and many times as much could be added — is it any wonder that I believe it to be a common-sense, a scientific, a moral, and a Christian duty to promote experimental research? To hinder it, and, still more, to stop it would be a crime against the human race itself, and also against animals, which have benefited almost as much as man from these experiments.

What do our antivivisection friends propose as a substitute? Nothing except clinical — that is, bedside — and *post-mortem* observations. These have been in use for two thousand years and have not given us results to be compared for a moment with the results gained by experimental research in the last fifty, or even the last twenty-five years.

For a tabular contrast between the beneficent results of experimental research and the utter futile results of the years of agitation by the antivivisectionists, see *post*, p. 280.

[1] See the statements and Resolutions on pp. xv–xviii.

THE INFLUENCE OF ANTIVIVISECTION ON CHARACTER[1]

"In this controversy [vivisection] there should be no bitterness. . . . Do not let us attempt to browbeat or call names. . . . Vivisection tends to weaken character. . . . Nothing which hurts the character can be right." (Rev. Dr. Floyd W. Tomkins, President of the American Antivivisection Society, in the *Ladies' Home Journal*, March, 1910.)

I ACCEPT the test proposed by Dr. Tomkins, and quoted in the above motto, "Nothing which hurts the character can be right." Let us, therefore, study what is the effect of antivivisection on the character of its advocates.

I. Violent Passions aroused by Antivivisection Agitation

The most violent and vindictive passions have been aroused and fostered, especially among women — the very flower of our modern civilization. Let us see whether they have shown "bitterness" or "called names." I have rejected much oral testimony I could use and have drawn my evidence from only a very small portion of the literature at my disposal.

Herewith I reproduce (Fig. 1) the photograph of a remarkable letter which contains an asserted prayer to the Deity calling down curses by "a dozen women" on my long-since sainted mother. It needs no comment from me save that the "horror" mentioned in this letter was excited by an article which I published in the "Ladies' Home Journal" for April, 1910, in which I recited a few of the *benefits to humanity* which had resulted from vivisec-

[1] An address read before the Surgical Section of the Suffolk District Medical Society, Boston, March 20, 1912. Reprinted by the kind permission of the editor and the publisher from the Boston *Medical and Surgical Journal*, May 2 and 9, 1912.

Arch-Fiend:

I read with horror you article in the Ladies' Home Journal on vivsection.

I hope your mother if she is living will die in the most terrible torture, and if she is dead that her soul will never know rest for having given life to such a vile monster as you is the nightly paayer of

a dozen women who

indited this

FIG. 1. Photograph of a letter received by myself in August, 1910. Both envelope and letter were typewritten, with no place, no date, and no signature; only the postmark showed that the letter came from Los Angeles.

tion. The only clue even to the place from which the letter comes is the postmark, "Los Angeles."

Let me quote another earlier anonymous letter I have before me. This is from Philadelphia. Instead of the usual address, "Dear Sir," it begins, "You Fiend." I had not then been promoted to "Arch-fiend" in Satan's hierarchy. The writer exclaims, "Oh, that you all could be put through the same torture that you inflict on these helpless ones." As I am not a vivisectionist this ardent wish fails to terrify. I am an advocate of vivisection because I *know* how greatly it has helped me during all my professional life in saving life and lessening suffering.[1]

[1] In the *American Journal of the Medical Sciences* for July, 1865, p. 67, Dr. S. Weir Mitchell, the late Dr. Morehouse, and I published a paper on the "Antagonism of Atropia and Morphia," based on observations and experiments in the Army Hospital for Injuries and Diseases of the Nervous System. The reason which caused us to make this investigation was that we desired to find better means for "soothing the pain of those terrible cases of neuralgia" following gunshot wounds of large nerves. These are accurately described in the paper as causing "anguish" and "agony" — no word could be too strong. "A Hell of Pain" was the accurately descriptive title one patient gave to our hospital. These patients often wore cotton gloves and high boots and always carried in their pockets a bottle of water which they poured from time to time on their gloves and into their boots, since the least dry friction was simply intolerable.

Accordingly, in our efforts, we tried a number of common and some uncommon drugs, and finally found that morphin (the active principle of opium) was the best remedy and yet had many disadvantages. Ultimately we found that by combining with it a certain amount of atropin (the active principle of belladonna) we obtained the best results. The facts discovered in our investigations have long since become merged in the common knowledge of the profession, and standard tablets with different proportions of the two drugs are manufactured and used all over the world. Most of our patients operated on (entirely by hypodermic injections) were sorely in need of relief. A few were convalescents. In all cases we avoided telling them what drug was being used, for every one knows how imagination, fear, or other emotion would alter the rate of the pulse or of the breathing. Not one man was injured in the least. Not one ever complained. Since then many thousands of human beings have been greatly benefited and many lives have been saved through the knowledge thus obtained.

I have expressly mentioned these facts in some detail because we have been attacked in their pamphlets by the antivivisectionists for these

If two letters will not convince, here is a third. This, from Baltimore, also the result of the same article, was from a writer who had the courage to sign her name and address: —

You would appear even the more fiendish on account of your superior intelligence. . . . The future of a vivisectionist is a veritable hell. You, I understand, are a man advanced in years [the calendar, alas! seems to justify this shocking statement] soon to go before the bar of justice. Can you meet your God with the terrible cries ringing in your ears of these creatures, our helpless brothers, made by his hand, that you have drawn and quartered? How they must haunt you. . . . When your time comes to die, every cry of pain and anguish that you have been the cause of producing in these helpless creatures will follow you to the depths of hell.

Yet I have "drawn and quartered" not even so much as a mouse.

But this same lady tells me that she had survived one of the most serious abdominal operations that could be done — a hysterectomy.[1] This operation was so perilous that until Lister had devised the antiseptic method it was never even thought *possible*, and its success at the present day is due chiefly to experiment on animals. The writer of the letter, therefore, is herself a witness to the benefit of vivisection.

Later on she says, "If they would only use vivisectors for their experiments, it would soon be considered unnecessary." Her gentlest wish, therefore, is for human vivisection, and doubtless "without anesthetics." Per contra, in the newspapers of May 6, 1911, a dispatch states that seventeen medical students had offered themselves for experimental inoculation with cancer, an offer which was, of course, refused, as animals can be used.

experiments, which are described as "Human Vivisection." What would they have had us do? Sit idly by and let these poor fellows suffer torments because if we tried various drugs we were "experimenting" on human beings?

[1] Removal of the entire womb.

A curious statement in the letter is, "I understand the Rockefeller Institute has had four or five of its laboratories burned, the animals destroyed, rather than have them fall into the hands of these wretches, and if this thing were more widely known, every medical college in the country would be razed to the ground and the doctors tarred and feathered." The insurance companies, I am quite certain, have never heard of the one laboratory which the Rockefeller Institute possesses having been burned. But what a strange exhibition of kindness it is to gloat over the fact that the poor animals in these supposed laboratories had been roasted to death "without anesthetics."

If three instances are not sufficient, here is a fourth — a signed letter from Chicago. Referring to one case which I had published as an illustration of the value of vivisection in saving human life, she says, "My sympathy for the parents of that young man . . . would have been deep, but not so keen as for a mother dog who saw her puppy tortured to death on a dissecting table. . . . Even if you did save a man's life, *was it worth while?*" (Italics in the letter!) This lady wrongly assumes that the puppy was "tortured to death," i.e., without anesthetics. This, I am glad to say, is not true, as I shall show later on. To her question, "Was it worth while?" I can only say, "Ask his father and mother."

And this is the ennobling influence of antivivisection!

A fifth communication is from a lady who was personally acquainted with myself and my family. She sent me a pamphlet with some good advice, ending with the terse injunction, "Do God's work, not the Devil's," and had the courage to sign her name.

A sixth lady sent me (anonymously) an article from one of our magazines, with many marginal annotations and much underscoring. From this I select a few sentences.

Millions of people regard him [the vivisector] with loathing, and shudder with horror at his name. . . . Frightful as the suffer-

ings of this tortured dog must be, I would rather be in its place than yours when your soul is summoned to its final judgment to receive judgment without mercy. [This seems to be a favorite threat of my correspondents.] May God so deal with every fiend incarnate who has thus tortured defenseless creatures. . . . All the demons and fiends do not dwell in Hades. Some are made in the image of God, but have hearts blacker and more cruel than the arch-fiend himself. These are the vivisectors who "benefit" mankind.

I have received very many more such letters — usually anonymous. These six may serve as samples.

I would willingly accept the supposition of unbalanced minds as an explanation and palliation for such letters but for their number and for the fact that they so entirely coincide with almost all the "repulsive literature" (to use Lord Coleridge's words) published by the various antivivisection societies.

A brief search through only a part of my file of this antivivisection literature enables me to cull the following evidences of a similar debasing violence and vindictiveness. The list could easily be extended.

The art of torture has been carried to a perfection which the devildoms of Spain in the old days of the Inquisition could not equal in ingenuity or pitilessness.

Vivisection is the anguish, the hell of science. All the cruelty which the human or rather the inhuman heart is capable of inflicting is in this one word. Below it there is no depth. This word lies like a coiled serpent at the bottom of the abyss.

Animals are dissected alive — usually without the use of anesthetics.

The vivisector keeps his victim alive while he cuts it up.

Vivisection founded on cruelty, supported by falsehood, and practiced for selfish ends.

The vivisector is less valuable to the world than the animals he destroys.

A thing I know to be damnable whatever the results.

An organized system of barbarity.

Vivisector and criminal become interchangeable terms.

Cowards who perpetrate hideous crimes.

Experiments on living animals is a system of long-protracted agonies, the very recollection of which is enough to make the soul sick as if with a whiff and an after-taste of a moral sewer.

Impious barbarity of the vivisector.

All other forms of sinful cruelty are comparatively trifling compared with the horrors of vivisection.

Deliberate dabbling in blood and agony.

Cruelty the inevitable and odious spawn of secret vivisection.

Blood-stained hands of the grim tormentors.

Bloody mass of agony.

Devilish inventions of unbalanced mentality.

At a hearing before a committee of the Legislature of Pennsylvania, I heard myself and others who were advocating the humane work of vivisection called "hyenas" by a woman.

Briefer descriptive terms are as follows: —

scientific hells	temples of torment
torture-house	cruelty of cruelties
orgy of cruelty	infernal work
halls of agony	hellish wrong
inhuman devil	devil's work
devils incarnate	lust of cruelty
scientific murder	scientific assassination
abominable sin	torture of the innocent
devilish science	black art of vivisection
fiends incarnate	satanic
damnably mean	fiends
arch-fiend	human monsters
master demon	demons
diabolical vivisection	working model of hell

Antivivisection writers nearly always state, assume, or imply that all experiments are "tortures," i.e., that anesthetics are not used. This is wholly erroneous.

In Great Britain, where all experiments are returned to the Government, the following table for 1906 (the latest I happen to have) will show how utterly indefensible is such an assumption. It is a fair presumption that about the same average exists in the United States.

	Per cent.
Inoculations, etc., not involving any operation	93.96
Animals killed under anesthetics	3.44
Animals allowed to recover from anesthetic but nothing likely to cause pain and no further operation allowed without anesthetic	2.60
	100.00

In other words, only *twenty-six animals out of one thousand* could by any possibility have suffered *any* pain, and very few of these any serious pain. Is this the torture and agony so constantly harped on?

[Since this address was delivered the report of the British Royal Commission on Vivisection, on which the antivivisectionists were represented, has appeared. One of their *unanimous* conclusions (page 20) is as follows: —

"*We desire to state that the harrowing descriptions and illustrations of operations inflicted on animals, which are freely circulated by post, advertisement, or otherwise, are in many cases calculated to mislead the public, so far as they suggest that the animals in question were not under an anesthetic. To represent that animals subjected to experiments in this country are wantonly tortured would, in our opinion, be absolutely false.*"

This clear statement should end this calumny.]

Many of the instances cited in antivivisection literature are taken from researches — such as Magendie's — which were made before anesthetics were discovered, over sixty-five years ago.

The rest in which real cruelty was inflicted, and which if done now would be condemned by all modern research workers as freely as by the antivivisectionists themselves, were done almost wholly on the Continent, and often by persons who are now dead. In discussing vivisection to-day, these should be excluded, or their dates and countries indicated, for the public, ignorant of medical history, is misled into supposing that these persons are living and practicing these methods to-day and in America.

In one of the anonymous replies to my paper on the "Misstatements of Antivivisectionists," [1] I am represented as the apologist and advocate of experiments of which twice over at the Senate Committee hearing and again in my letter to Mr. Brown I had expressed my utter disapproval. I am always willing to face a truthful charge, but it is a hopeless task to meet untruthful charges, especially when the author is ashamed of his own name.

"Hell at Close Range" is the title given by Miss Ellen Snow to a leaflet dealing with the work of the Rockefeller Institute. One could scarcely expect such fierce heat from so frosty a name.

At this institute, by experiments on twenty-five monkeys and one hundred guinea-pigs, most of which animals recovered, has been discovered a serum that has brought the former death-rate of cerebro-spinal meningitis of seventy-five or ninety per cent down to twenty per cent and less. Is it because of this beneficent work that it is called "hell"?

At this institute has been discovered a means of transfusion of blood that has already saved scores of human lives. Is this the reason for calling it "hell"?

At this institute a method of criss-crossing arteries and veins, which almost always run alongside of each other, has been discovered by which impending gangrene has been prevented. Does this make it a "hell"?

At this institute the cause and the cure of infantile paralysis are being sought. Are such investigations carried on in "hell"? [2]

Miss Snow in this same leaflet expresses in italics her horror at the idea of the proposition of the institute "to build a hospital where the experiments may be continued on human beings." It may be of interest to her and also

[1] *Ante*, p. 110.

[2] Since this was written the germs of infantile paralysis and of hydrophobia have been discovered at this same institute.

to others to know that this hospital was opened in October, 1910, and that the public, undeterred by her horror, have thronged to it in such numbers that there have not been beds enough for the several hundreds of disappointed applicants.

An editorial in the "Journal of Zoöphily"[1] records a gift to this Rockefeller Institute, "an institution in New York where vivisection should be practiced with the idea of achieving as great an advance as possible in the war of science against human suffering," and adds, "but the gift only fanned into fury the opposition of the women to experiments on living animals, *no matter how great the anticipated benefit.*" Could cruel passion be better expressed?

Can a cause which so seriously injures the character of its advocates that they indulge in this prolific vocabulary of vituperation by any possibility have an uplifting influence? It eminently fulfills Dr. Tomkins' proposed test — it "hurts the character and, therefore, cannot be right."

Are those who give loose rein to such passion fitted to form a sound and sane judgment on the subject about which they write? This is especially true when the matter is one so technical as anatomic, physiologic, chemical,

[1] *Jour. of Zoöphily*, January, 1909, p. 2.

In my opinion other antivivisection journals are not worth the time or the money, but this one — the *Journal of Zoöphily* — is my stand-by. Of course its columns, like those of all its tribe, are filled with much fiction, but it often reminds me of the good-humored epigram of a witty husband to his wife, "My dear, you are usually wrong, but you are never dull." Its annual tome of somewhat over two hundred pages requires the combined energies of four editors, beginning with the hyphenated "Editor-in-Chief." It outshines the "Outlook" now for it still has a "Contributing Editor," who, with becoming dignity, contributes only on special occasions. Its price is "one dollar per annum" — only twenty-five cents per editor! For shame!

Its office is just around the corner from my house. Among a swarm of florists' and opticians' and other shops, it is our sole literary attraction. Appropriately also it is very neighborly. It raps on my door each month (though generally sadly belated) and whenever I wander *too* far from the path of virtue, it also raps on my head. I find it very entertaining.

pathologic and surgical investigations as to which they cannot be expected to know and, in fact, do not know anything. Even relatively few medical men are fitted by temperament and training to act as censors of such researches, much less those ignorant of medicine.

I believe that much of the passion shown in the above quotations is the result of ignorance. Most of the attacks on vivisection, as I have said, assume or even state categorically that anesthetics are not used. Saving in the *very* rare cases in which the use of anesthetics would entirely frustrate the experiment, anesthetics are always used. This is done not only for reasons of humanity, but also because the struggles of a suffering animal would make delicate and difficult operations absolutely impossible, to say nothing of the danger of injury to the operator.

The always-quoted opinion of Professor Bigelow was founded on what he had seen at the Veterinary School at Alfort, France, in the pre-anesthetic days. (See p. 278.)

Many absolutely false statements are made that anesthetics were not used in certain specified experiments, whereas the experimenters have expressly stated that anesthetics *were* used. Of such misstatements by antivivisection authors I shall give some startling instances later. It is no wonder that the public has been thus misled. "Cutting up men and women alive" is an accurate description of every surgical operation, but we all know that while in comparatively few reports of surgical operations it is expressly stated that an anesthetic was used, such use "goes without saying."

One of the most frequent antivivisection statements is that "incomplete" or "slight" or "light" anesthesia means that the animal is fully able to feel pain and that when the eye resents a touch or there is muscular movement following any act which would be painful when one is not anesthetized, pain is actually being inflicted. Mr. Coleridge says (Question 10,387 in his testimony

before the Second Royal Commission on Vivisection), "What does 'anesthetized' mean? It means 'without feeling.' You cannot be slightly without feeling. You either feel pain or you do not."

Very recently when I had nitrous oxid gas given several times to a lady to bend a stiff elbow she struggled and writhed so hard as almost to throw herself out of the dentist's chair on to the floor. *Yet she was never conscious of the slightest pain.* In other words, while the motor nervous centers responded to my forcible bending movements and caused violent muscular struggles, the perceptive nervous centers felt no pain. But any spectator would surely have said that she was being "tortured." This is only one of hundreds of similar cases I have had; all other surgeons have had similar experiences.

In modern laboratory researches, ether or other anesthetics are almost always given. Extremely few exceptions occur, and then only with the consent of the director in each specific case. The actual conditions at the present day are well shown by the rules in force in practically all American laboratories of research. These rules have been in operation for over thirty years in one case and for more than ten years in others. In most laboratories in which students work, and where they are absolutely under the control of the director, the only animal used is the frog, and by "pithing" or decapitating it, it is made wholly insensible to pain.

The idea that students privately "torture" animals, often, it is stated, out of mere curiosity, is absolutely false. I have been intimately associated with students ever since 1860, first as a student and since 1866 as a teacher. I state, therefore, what I am in a position to know. Moreover, private experimental research takes time which our overworked students do not have, and money which they cannot afford. It means the rent of a laboratory, the purchase of very expensive and delicate

instruments, the rent of an animal room, the cost of the animals, and of their food and care, a man to look after them, — for all modern surgical work on animals must be done with the same strict antiseptic care as on man or the experiment will surely fail and discredit the author, — a total expense amounting to a very large sum.

I quote in full the rules which, as I have said, are in force in practically all American laboratories of research:—

Rules Regarding Animals

1. Vagrant dogs and cats brought to this laboratory and purchased here shall be held at least as long as at the city pound, and shall be returned to their owners if claimed and identified.

2. Animals in the laboratory shall receive every consideration for their bodily comfort; they shall be kindly treated, properly fed, and their surroundings kept in the best possible sanitary condition.

3. No operations on animals shall be made except with the sanction of the director of the laboratory, who holds himself responsible for the importance of the problems studied and for the propriety of the procedures used in the solution of these problems.

4. In any operation likely to cause greater discomfort than that attending anesthetization, the animal shall first be rendered incapable of perceiving pain and shall be maintained in that condition until the operation is ended.

Exceptions to this rule will be made by the director alone, and then only when anesthesia would defeat the object of the experiment. In such cases an anesthetic shall be used so far as possible and may be discontinued only so long as is absolutely essential for the necessary observations.

5. At the conclusion of the experiment the animal shall be killed painlessly. Exceptions to this rule will be made only when continuance of the animal's life is necessary to determine the result of the experiment. In that case, the same aseptic precautions shall be observed during the operation, and so far as possible the same care shall be taken to minimize discomforts during the convalescence as in a hospital for human beings.

[Signed] .....

Director of the Laboratory.

I may add that at the Rockefeller Institute regular trained nurses are employed and are on duty not only during the day, but at night when necessary.

Self-confessed total ignorance of a subject on which one gives extensive evidence is not often known, but Dr. Herbert Snow, of London, an authority among the antivivisectionists, is a case in point. Dr. Snow's evidence before the Royal Commission on Vivisection (1906) covers ten pages quarto and he answers three hundred and twenty-six questions. In 1911, Dr. Snow visited America. In a letter to the Philadelphia "Ledger"[1] he makes the almost incredible statement that he gave all this evidence "in utter ignorance of the vivisection question."

Moreover, when asked by the Commission (Question 2242), "Do you find any fault with the present gentlemen who are licensed under the act"? he replied, "I do not"; and again (Questions 2227 and 2228) he admits that both painful and painless experiments may sometimes be necessary.

In other cases ignorance of physiology and anatomy is shown which would only excite a smile did it not gravely mislead the reader. I shall give only a single illustration here. Others will be found elsewhere in this paper.

"The Nine Circles," with its sulphurous subtitle, "Hell of the Innocent," is an English book originally issued by the late Miss Frances Power Cobbe, in 1892. This edition had to be withdrawn on account of its false statements, especially as to the non-use of ether.[2] A second and revised edition was issued in 1893. This was "carefully revised and enlarged by a subcommittee especially appointed for the purpose," as the preface states.

On page 15 of the revised edition, it is correctly stated that Professor Henry P. Bowditch, of the Harvard Medical School, in some experiments on the circulation, etherized a cat and that "then its sciatic nerve was

[1] Philadelphia *Ledger*, March 6, 1911. [2] See *post*, pp. 265, 266.

divided," etc. The sciatic nerve is the largest nerve in the body of man and animals and passes down the back of the leg. After division of the nerve the portion going down the leg *below* the place where the nerve was divided was stimulated by an electrical current. As this part of the nerve was wholly cut off from the spinal cord and brain, *by no possibility could any pain be felt.* Yet a Boston lawyer, in a leaflet published by the New England Antivivisection Society, comments on a similar experiment as follows: "It will be readily seen even by the casual reader that it involves an amount of agony beyond which science is unable to go." Just how the "casual reader" would be so well informed as to physiology when a lawyer and two doctors — not casual but intelligent and careful readers — got things totally wrong, is not stated. Dr. Bowditch published a correction[1] of this misstatement in 1896. In spite of this, the New England Antivivisection Society in 1909, *thirteen years* after this public correction, was still distributing this lawyer's statement.

But in "The Nine Circles" (second edition, carefully revised by Dr. Berdoe and the committee) these experiments are referred to as "experiments on *the spinal cord*"! (Italics mine.) Yet Bowditch did no operation on the spinal cord. Miss Cobbe, not being an anatomist, might be pardoned for confusing the thigh and the spine of the cat, but surely Dr. Berdoe ought to have seen to it that "sciatic nerve" and "spinal cord" were not used as interchangeable terms.

Many years ago, after amputating a leg near the hip, I tried to see now long electric stimulation of the sciatic nerve would cause the muscles of the amputated leg to contract. After four hours, during all of which time the muscles continued to react, I had to stop as I could give no more time to the experiment. According to the canons of antivivisection as voiced above, I should have

[1] Henry P. Bowditch, *Advancement of Medicine by Research*, p. 43.

continued to etherize the patient whose leg had been amputated, for he, just as much as Bowditch's cat, could feel "agony beyond which science is unable to go."

Let me give only two other surprising statements. Dr. Hadwen[1] criticizes my reference in "Harper's Magazine"[2] to "an astringent named 'adrenalin.'" I had shown how valuable adrenalin had been in saving human life in certain surgical conditions, and also described the resuscitation, by means of adrenalin and salt solution, of a dog which had been "dead" for fifteen minutes. Dr. Hadwen concludes his paragraph thus: "But it does seem a pity that these New World vivisectors will not be able to perform the resurrection miracle without first killing somebody to get at his kidneys." The presumable object of "getting at his kidneys" would be in order to make adrenalin from them. Now adrenalin is *not made from the kidneys at all*, least of all from human kidneys, but from the adrenal glands of animals.

In the same article he vaunts the use of salt solution instead of the direct transfusion of blood, and rightly says that he has "seen the most marvelous effects follow the injection of an ordinary saline solution into the venous system in cases of loss of blood." But he seems to be ignorant of the fact that this very saline transfusion was begun and perfected by experiments on animals. I commend to him Schwarz's essay (Halle, 1881) with its twenty-four experiments on rabbits and dogs, and Eberius's essay (Halle, 1883) with its ten experiments on rabbits and the record of eleven cases in which Schwarz's method had already been used in man. These essays were practically the beginning of our knowledge of the advantages of the use of salt solution over the old dangerous methods of transfusion of blood.

[1] Hadwen, *Jour. of Zoöphily*, January, 1910.

[2] W. W. Keen, "Recent Surgical Progress," *Harper's Magazine*, April, 1909; reprinted in this volume, *ante*, p. 151.

The antivivisectionists deny the truths of bacteriology. Yet we practical physicians, surgeons, and obstetricians *know* by daily experience that Pasteur's and Lister's researches are the basis of most of our modern progress. Are Hadwen, Harrigan, Snow, and their colleagues right, and have all medical colleges all over the world, in establishing chairs of bacteriology, and all medical men, in believing bacteriologic diagnosis of such importance and in basing on the germ theory their antiseptic treatment, which has so revolutionized modern surgery, been wholly wrong? The germ theory is as well established as the doctrine of the circulation of the blood.[1]

II. Fostering a Spirit of Cruelty to Human Beings

My second reason for believing that antivivisection injures character is that, by putting a greater value on the well-being and the lives of monkeys, guinea-pigs,

[1] In Mrs. White's answer to this address (Boston *Med. and Surg. Jour.*, July 25, 1912, p. 143), as the editor on p. 131 points out, her reference to the "fever inseparable from the healing of abdominal wounds" shows her ignorance of the results of modern progress in surgery. Thanks to bacteriology and the antiseptic method of Lister and his followers, thousands of surgeons and patients the world over can confirm my own experience, both as a surgeon and as a patient, that *no* fever usually follows a clean abdominal operation. Before Lister's day, not only was there the terrible fever and suffering of peritonitis, but the mortality was so great that we never dared to do many operations which are now commonplace and rarely fatal. Another illustration of ignorance of surgery is found in Mrs. White's reference (p. 143) in the same paragraph to the "pain caused by the presence of gall-stones in the gall-bladder," a pain which she says "is generally considered the most violent pain known." Now, it is true that sometimes "gall-stones in the gall-bladder" do cause some or even considerable pain; but many *post-mortem* examinations reveal "gall-stones in the gall-bladder" which have never given the patient the slightest pain, and the patient, therefore, was totally ignorant of their presence. The "violent pain" to which she refers is not due to their presence in the gall-bladder, but to the terrible "gall-stone colic" caused by the passage of the gall-stones out of the gall-bladder into its duct, or tube, opening into the bowel. Modern antiseptic surgery prevents these constantly recurring attacks by safely removing the gall-stones from the gall-bladder or from the gall-duct.

rabbits, dogs, cats, mice, and frogs than on the lives of human beings, it fosters a spirit of cruelty to human beings.

Is it not a cruel passion which will lead men and women to write such letters and to print such epithets as I have quoted? Is it a right thing to misstate the facts of operations, and after the falsity of the charge has been proved, still continue for years to hold up men with human feelings and sensitive to abuse before the community as vile monsters of cruelty? Nay, more than this, is it not an extraordinary thing that those who so vehemently denounce human vivisection are even among its advocates?

When I was professor of surgery in the Woman's Medical College of Pennsylvania, I took as the topic of my address at one of the commencements, "Our Recent Debts to Vivisection."[1] Mrs. Caroline Earle White published "An Answer to Dr. Keen's Address entitled, 'Our Recent Debts to Vivisection.'" At the bottom of page 4 I find the following: —

> I take issue with Dr. Keen in the second place where he says, "These experiments cannot, nay, must not, be tested first upon man." I assert, on the contrary, that *in the majority of cases they must be tested first upon man* [italics my own] or not tested at all, because no important deductions can ever be drawn with any degree of certainty from experiments upon animals, since in some inexplicable way their construction is so different from that of man.

The statements in the latter portion of the concluding sentence will much amuse anatomists, physiologists, and biologists, or, in fact, any one who really knows anything about science. With minor modifications, man and the lower animals are alike in almost all particulars, both in structure and function, in health and disease.

The extraordinary fact is that Mrs. White asserts that experiments must be tested *first* on men or not tested at all.

[1] See the first paper in this volume.

That is to say, we must either experiment on human beings or else continue in exactly the same old rut as before and never make any progress, for every departure from prior practice, however slight, is an "experiment."

If this basic doctrine of antivivisection had held good, for the last fifty years Lister would not have been able, after carefully testing his antiseptic method on animals and having found it successful, then, and not before then, to try it on man.[1] By this means he became, as the "British Medical Journal" has just called him, "the maker of modern surgery."

On page 10 of Mrs. White's "Answer" is found the following flat-footed advocacy of human vivisection: —

> Dr. Keen mentions that in India alone twenty thousand human beings die annually from snake bites and as yet no antidote has been discovered. How can we search intelligently for an antidote, he says, until we know accurately the effects of the poison? I should reply that in order to find out the effects of the poison and to search also for an antidote, the best plan would be for the experimenters to go to India where they could find as large a field for investigation as they require in the poor victims themselves. *Here is an opportunity such as is not often offered for experimenting upon human beings*,[2] since as they would invariably die from the

[1] W. W. Keen, "Modern Antiseptic Surgery and the Rôle of Experiment in its Discovery and Development," *Jour. Am. Med. Assn.*, April 2, 1910, p. 1104. Reprinted in the series of pamphlets on Defense of Research (see p. xix), and in the present volume, *ante*, p. 199.

[2] In her answer to this address (Boston *Med. and Surg. Jour.*, July 25, 1912, p. 143), Mrs. White, after twenty-seven years for reflection, defends her proposal for "experimenting on human beings," saying that "it does not seem to me that this is a cruel suggestion, as my only object in it was to benefit the poor natives who die by the thousand every year." Such a defense places her clearly and definitely among the advocates of vivisection, whose only "object" is to prevent death "by thousands every year." This object, moreover, has already been obtained in a score of diseases and will be obtained hereafter in many others, not, however, by "experimenting on human beings," as she advocates, but on dogs, cats, rabbits, guinea-pigs, mice, frogs, etc.

And now the associate editor of the *Journal of Zoöphily*, in the last issue of her journal I have received (July, 1914, p. 101), *horribile dictu*, enters *her* plea for vivisection! She holds with her London hero, Dr. Snow, that

snake bites, *there can be no objection to trying upon them every variety of antidote that can be discovered.* Nothing seems to me less defensible than these experiments on the poison of snake bites upon animals since it is the one case in which they could be observed with so much *satisfaction and certainty upon man!* [Italics my own.]

Such a proposal is as absurd as it is cruel. Even if the experimenter could afford sufficient time and money to go to India for months or rather for years, how could he arrange to be present when such unexpected accidents occurred? How could he have at hand in the jungle the ether, chemicals, assistants, tables, tents, food and drink, and the necessary yet intricate and delicate instruments? And even if he had all of these, how could he work with the calmness and the orderly deliberation of the laboratory when a fellow human being's life was ebbing away and every minute counted in such a swift poison? The proposal is cruel and revolting and would never be accepted by any investigator.

But Mrs. White is not the only one who is guilty of making such a proposal. Many antivivisection leaflets and pamphlets express the wish that the vivisectors should be vivisected. In a pamphlet[1] freely distributed in the United States I find the following in a letter from a man who was at that time a Senator of the United States: —

> It would be much better to dissect men alive occasionally for the general welfare because the attendant phenomena and demonstration of the victims being of our own particular form of animal would be far more valuable than the result of our observation upon the physical structure illustrated in the agonies unto death of the helpless creatures around us.

"*research among the lower organisms is the main path to be followed in the ages yet to be.*" True it is claimed that "it would not inflict a pang on any sentient creature." Yet it is also asserted that the health of these lower organisms "primarily depends on the condition of its [their] *nerves.*" Pray what are nerves for?

[1] Frances Power Cobbe, and Benjamin Bryan, *Vivisection in America*, p. 15.

The English is as distressing as the proposal is astounding.

Let me give one more illustration of the effect of anti-vivisection in encouraging cruelty.

To-day the plague, cholera, and yellow fever no longer terrify Europe or America. What is the reason for this? Primarily and chiefly the discovery of the germs of cholera and of the plague by bacteriologic methods, which in turn are very largely the result of experiment on animals, and of the means of the transmission of yellow fever, though as yet not of its cause. In the latter case experiments on animals were out of the question because it is impossible to transmit yellow fever to animals. They are not susceptible to the poison. So a number of noble medical men and others volunteered to have experiments tried on them. The very first experiments were tried on medical men. These men slept in a stifling atmosphere for twenty nights in the beds in which yellow fever patients had died, and in their very clothes, — clothes soiled with their black vomit, urine and feces; tried to inoculate themselves by putting some of the black vomit into their eyes, or by hypodermic injections, etc., but all in vain. By none of these methods were they able to inoculate themselves with the fever. One step more was requisite — to learn whether a well man bitten by an infected mosquito, but having been exposed to no other possible source of infection, would contract the disease. Dr. Carroll, of the army, was the first to offer himself, and nearly lost his life. Others followed. Several lost their lives, among them Dr. Lazear, at the beginning of a most promising career.[1]

Contrast with this a cruel letter[2] written by a woman:

> Science is based on such firm foundation, indeed, that it can at a moment's notice be tumbled down and become a wrecked mass by a mosquito! Not only this, but these lifelong vivisectors could not even prolong their own lives. Undone by a mosquito! *I shall always have unbounded admiration for that clever insect.* [Italics mine.]

[1] See *ante* p. 229.

[2] New York *Herald*, August 2, 1909.

This self-sacrifice for humanity has made us masters the world over of yellow fever, has made possible the Panama Canal, has saved many thousands of human lives and millions of dollars in our own Southern States alone, and yet a woman can feel "unbounded admiration for the clever insect" which slew these heroes and had devastated cities and countries for centuries! Does not such antivivisection zeal "hurt character"?

Two men are especially obnoxious to the antivivisectionist: Pasteur, whose demonstration of the cause of that form of infection known as puerperal or childbed fever alone would have made his name immortal; and Lister, whose application and extension of the principles laid down by Pasteur have revolutionized all modern surgery.

I need not argue the case for Pasteur, Lister, and modern antiseptic surgery. Excepting the antivivisectionists, every intelligent man and woman the world over *knows* that modern surgery has been made safe by their researches. Let me give a single instance.

In the charming "Life of Pasteur" by René Vallery-Radot, it is stated[1] that, hoping to overcome the almost invariably fatal results of ovariotomy in the hospitals, the authorities of Paris "hired an isolated house in the Avenue de Meudon, a salubrious spot near Paris. In 1863 ten women in succession were sent to that house. The neighbors watched those ten patients entering the house, and a short time afterward their ten coffins being taken away!"

To-day, thanks to Pasteur and Lister and modern surgery, based on experiment on animals more than on any other foundation, not more than two or three in a hundred die after ovariotomy. Yet, if the antivivisectionists had prevailed, the horrible mortality of the earlier days and even the tragedy of the ten women and the ten coffins would still exist. Is not this cruelty?

[1] Vallery-Radot, *Life of Pasteur*, vol. II, p. 16.

Let me take another illustration of a similar cruelty, a form especially interesting to women. Professor J. Whitridge Williams,[1] professor of obstetrics in the Johns Hopkins University, states the following facts: In 1866 Lefort showed that in 888,312 obstetric cases in the hospitals of France up to 1864, 30,394 women had died of puerperal fever; that is to say, 3.5 per cent, or about every twenty-seventh mother. From 1860 to 1864 the mortality in the Maternité of Paris had risen nearly fourfold, to 12.4 per cent. In December, 1864, it rose to 57 per cent; that is to say, *more than one half* of the women who bore children in that hospital in that month died of childbed fever! In Prussia alone, in the sixty years from 1815 to 1875, Boehr showed that 363,624 women had died of the same fever and estimated that every thirtieth prospective mother was doomed to death from that cause. In the United States, Hodge, of Philadelphia, showed that in the Pennsylvania Hospital, from 1803 to 1833, there had been a mortality of 5.6 per cent; i.e., every eighteenth mother was doomed. Lusk reported an epidemic in 1872 with 18 per cent; that is, almost every fifth mother perished from the same fever!

As late as March, 1879, only thirty-three years ago, at the Paris Academy of Medicine, when the leading men in a debate on childbed fever were at a loss to account for it, Pasteur drew on the blackboard what we now know as the streptococcus and declared this little vegetable organism to be its cause. Our own Oliver Wendell Holmes, in 1843, was the first who declared on clinical grounds that the doctors and the nurses carried the contamination, but how and why he could not know, for bacteriology did not then exist. He was followed by Semmelweis, of Vienna, who, in 1861, still further reinforced the reasoning of Holmes,

[1] J. Whitridge Williams, "Obstetrics and Animal Experimentation," *Jour. Am. Med. Assn.*, April 22, 1911, p. 1159, and no. XVIII in the series of pamphlets on Defense of Research. (See p. xix.)

and for his pains was tabooed by his professional colleagues and ended his life in a madhouse.

The result of Pasteur's researches and the practical application of Lister's antiseptic method to obstetrics as well as to surgery have borne the most astounding and gratifying fruit. For instance, in 1909, Markoe reported in the New York Lying-in Hospital in 60,000 births a maternal mortality of only 0.34 per cent, and Pinard, in 1909, in 45,633 births recorded a mortality of only 0.15 per cent, while in 1907 Mermann had been able to report a mortality of only 0.08 per cent in 8700 patients! In other words, these reports show in round numbers that, taking in the two extremes, the deaths from childbed fever fell from the extraordinary rate of fifty-seven in a hundred mothers, or the former usual rate of five or six in every hundred mothers, to one mother in 1250.

If for fifty years past the antivivisectionists had had their way, all these marvelous results in obstetrics would have been prevented and women would still be dying by the hundred and the thousand from puerperal fever — an entirely preventable disease. Would it not have been the height of cruelty to stop these experiments? But according to the "Journal of Zoöphily" such wonderful life-saving experiments should be prohibited, "*no matter how great the anticipated benefit.*"

In surgery, erysipelas, blood poisoning, lockjaw, hospital gangrene, etc., would still be killing our patients right and left; weeks of suffering, to say nothing of danger, would confront every patient operated on; the modern surgery of the head, of every organ in the abdomen and pelvis, of tumors and of cancer, amputations and many other operations, instead of being almost painless and so safe as they are to-day, would be the cause of prolonged illness, pain and death; in fact, most of them would be deemed entirely impossible of performance — they *were* impossible before Pasteur and Lister — and animals themselves would still

be suffering as of old from animal maladies whose causes are now known and whose ravages have been enormously diminished.

Call you not the desire to arrest such experiments cruelty to man and animals alike?

In a speech in the House of Commons, April 4, 1883, Sir Lyon Playfair, the Deputy Speaker, said: —

> For myself, though formerly a professor of chemistry in the greatest medical school of this country [Edinburgh], I am responsible only for the death of two rabbits by poison, and I ask the attention of the House to the case as a strong justification for experiments on animals; and yet I should have been treated as a criminal under the present act [the British vivisection law] had it then existed.
>
> Sir James Simpson, who introduced chloroform, . . . was then alive and in constant quest of new anesthetics. He came to my laboratory one day to see if I had any new substances likely to suit his purpose. I showed him a liquid which had just been discovered by one of my assistants, and Sir James, who was bold to rashness in experimenting on himself, desired immediately to inhale it in my private room. I refused to give him any of the liquid unless it was first tried on rabbits. Two rabbits were accordingly made to inhale it; they quickly passed into anesthesia and apparently as quickly recovered, but from an after-action of the poison they both died a few hours afterward. Now was this not a justifiable experiment on animals? Was not the sacrifice of two rabbits worth saving the life of the most distinguished physician of his time?

As this experiment was not for the good of the two rabbits, but in fact, killed them, in the eye of present-day antivivisectionists it would be wrong, and, if they had their way, illegal and punishable, and Simpson would have lost his life. Would not this be cruelty?

Let me state briefly two of the most recent discoveries in medicine and surgery: —

1. *Vaccination against typhoid fever.* Starting from Pasteur's researches on animal diseases and continued by various observers, and especially in the last few years

by Sir Almroth Wright, of London, there has been developed, chiefly by experiments on animals, a "vaccine" to *prevent* typhoid fever. When by such experiments the method was found to be sufficiently safe, it was tried on man.

In the Boer War, and among the German troops in their African colonies, tentative trials of its value were made. Now it has been tried in the United States Army on a larger scale and with more astonishingly good results than in any previous trials.

During the Spanish War there were 20,738 cases of typhoid and 1580 deaths; nearly *one fifth of the entire army* had the disease. It caused over 86 per cent of the entire mortality of that war! In some regiments as many as 400 men out of 1300 fell ill with it. How this would handicap an army in the field — to say nothing of deaths — is evident.

Lately in our army on the Mexican border, for months under war conditions, except as to actual hostilities, *there has not been a single soldier ill with typhoid.* This is due partly to better sanitation (which in turn is due largely to bacteriology), but chiefly by reason of wholesale anti-typhoid vaccination. This is evident from the fact that during the year June 30, 1908, to 1909, when this vaccination was purely voluntary and the army was not in the field, proportionately *sixteen times* as many unvaccinated soldiers fell ill with the disease as compared with the vaccinated. On the Mexican border there has been only one single case of typhoid, not in a soldier, but a teamster who had not been vaccinated. So evident are the benefits of this preventive inoculation that Dr. Neff, the director of health of Philadelphia, has issued a circular proposing its municipal use, and also to prevent typhoid in our summer resorts. In many large hospitals it is extensively used to protect the physicians and nurses from catching the fever.

Would it not have been cruel to prevent such life-saving experiments?[1]

2. In surgery let me instance the surgery of the chest. This has been the region in which progress has lagged far behind that of all the other parts of the body till within the last five or six years. The reason was that the moment you opened the chest cavity to get at the heart, the lungs, the esophagus, the aorta or the pleura, it was like making an opening in the side of a bellows. The air, instead of being drawn in and forced out through the nozzle (corresponding to the mouth in the case of a patient), passed in and out through the opening in the side

[1] The Reports of the Surgeon-General of the Army for 1909 to 1912 show the following number of cases and deaths from typhoid fever: —

Year	*Cases*	*Deaths*	
1909	173	16	Protective vaccination was entirely voluntary but
1910	142	10	was gradually winning its way.
1911	69	8	September 30, 1911, it was enforced universally in
1912	27	4	the Army.
1913 1st 6 mos.	0	0	

Not a single case in the United States, Hawaii, Porto Rico, Panama, Alaska, or the Philippines! Meantime the army had increased in numbers from about 69,000 to over 83,000!

The conclusion of the Surgeon-General is that, as a result of the protection afforded by the anti-typhoid "vaccination," "typhoid fever will cease to be a scourge to the army in the future."

In the *Brit. Med. Jour.* for August 22, 1914, p. 369, is an "Appeal by the War Office" urging typhoid vaccination of the British soldiers engaged in the present European war. One fact is most impressive and exactly corresponds to the experience of our own American army. Though this protective vaccination is still only voluntary in the English army, "about 93 per cent of the British garrison of India have been protected by inoculation, and *typhoid fever, which used to cost us from three hundred to six hundred deaths annually was last year responsible for less than twenty deaths.*"

Doubtless our antivivisection friends will object, as they do in the case of diphtheria, smallpox, etc., to the introduction of such a "vile poison." What does common sense reply?

Since writing this I find in the *Open Door* (a New York antivivisection organ), in its issue for March, 1914, an article entitled "Typhoid Vaccine Fraud again punctured"! If we could find a similar "fraud" against scarlet fever, measles, whooping-cough, etc., what a blessing to humanity!

of the bellows or the chest. If only one side of the chest was opened, breathing was embarrassed, if both sides were opened, the patient's lungs collapsed, breathing was impossible, and death ensued.

Sauerbruch, then of Breslau, first devised a large air-tight box or chamber in which the pressure of the air could be increased or diminished at will. The body of the patient, the surgeons, nurses, and instruments were all inside the box, and a telephone enabled them to give directions to those outside, especially to the etherizer. The head of the patient with an air-tight collar around his neck protruded outside of the chamber where the etherizer also was placed. In such a chamber the chest could be safely opened. But while this was an immense improvement, such a chamber is clumsy, not easily transportable, and is very expensive. The method has done good service, however. It has been improved by others and is in use to-day by many surgeons.

At the Rockefeller Institute, Meltzer and Auer, by a number of experiments on animals, have lately developed a new, simple, and safe method of anesthesia with ether which is revolutionizing the surgery of the chest and to a considerable extent may even displace the ordinary inhalation method of anesthesia. As soon as the patient has been etherized in the ordinary way, a rubber tube is inserted into the windpipe through the mouth. By a foot bellows ether-laden air is pumped into the lungs through this tube, the foul breath escaping between the tube and the windpipe and out through the mouth. Experiments on animals showed that the rubber tube used for so long a time would not injure the vocal chords and so alter or destroy the voice of a patient, or cause injury to the lungs, and that the method was most efficacious in the surgery of the chest.

I saw Carrel thus keep a dog under ether for about an hour and a half; open both sides of the chest by one wide

sweep of the knife; displace the heart and lungs this way or that; expose and divide the aorta between two clamps (the clamps were applied in order to prevent immediate fatal hemorrhage); do a tedious and difficult operation on the aorta; unite its two cut ends; replace the heart and lungs, and close the wound. An hour later the dog, which showed no evidences of suffering, was breathing naturally, and in time recovered entirely.[1] What this method means in injuries and diseases of the heart, in gangrene, abscess and tumors of the lungs, in cancer of the esophagus, and foreign bodies lodged in the esophagus or in the bronchial tubes, and in diseases of the aorta, one can hardly yet even imagine.

These experiments have done more for the surgery of the chest in three or four years than all the "clinical observation" of cases in a thousand years. The method has already been tried successfully in several hundreds of cases in man, and the future has in store for us a new and most beneficent chapter in the surgery of the chest.

Yet, if the antivivisectionists had prevailed, all these experiments would have been prevented, the doors of the Rockefeller Institute nailed up, and men, women, and children have been deprived of the benefits of these splendid discoveries. Call you not that intensely cruel?

Moreover, these very same people, in their own households and without the slightest pity, will kill rats and mice by turning them over to the tender mercies of cats, by drowning them, by strangling them in traps, by poisoning them with strychnin or phosphorus, or by any other means of "torture"; but they hold up their hands in holy horror when any proposal is made to terminate the lives of other rats and mice almost always without pain and with immense benefit to humanity. They are cruel and callous to

[1] For these and other experimental researches Carrel has just been awarded the Nobel Prize in medicine — a splendid testimony to his genius from the first scientists of the world.

human suffering so long as dogs and cats, mice and guinea-pigs escape! And yet, as I have shown, only twenty-six animals in a thousand can possibly ever suffer at all!

That sentiment rather than principle is at the bottom of the antivivisection crusade is shown by what I in common with many others believe to be true, that if experimental research could be carried on on other animals without using dogs and cats there would scarcely have been any antivivisection movement.

III. Lessened Reverence for Truthfulness

The third way in which the influence of antivivisection injures character is by diminishing the reverence for truthfulness. In 1901 I gave many instances[1] of the misstatements of the antivivisectionists. These misstatements were contained in two anonymous pamphlets, and I have two more similar publications which are also anonymous. I have before me also three publications purporting to be replies to that publication of mine, all again anonymous. Is a foe who attacks from ambush worthy of the respect and confidence of the public?

These misstatements, so far as I know, are still distributed in leaflets and pamphlets without correction nearly eleven years after their incorrectness was shown. In fact, several of them reappear uncorrected in the "Journal of Zoöphily" for July, 1911.

Let me give a few new instances.

The most prominent antivivisectionist in England is Mr. Stephen Coleridge. On page 183 (April to July, 1907), in the minutes of his evidence before the Royal Commission on Vivisection, I find the following: —

Question 10952: We may have inspection, but still we may ask a person of character when he saw the experiment what his opinion of it was. Will you not accept that?

[1] W. W. Keen, "Misstatements of Antivivisectionists," *Jour. Am. Med. Assn.*, February 23 and August 10, 1901, and *ante*, pp. 110 and 135 of this volume.

Answer: Certainly not, because I think that all these experimenters have the greatest contempt for the Act of Parliament. They would deny a breach of this act just as I should deny a breach of the Motor-Car Act. I drive a motor-car, and *when I go beyond the speed limit* and the policeman asks me, I say, "*No, I am not going beyond the speed limit*[1] [italics mine]. Nothing would keep me from going beyond the speed limit except the presence of a policeman in the car; and nothing will keep the experimenter within the four corners of the act except an inspector in the laboratory.

Question 10953: Surely, if you were asked about the speed limit and gave your word that you had not exceeded it, you would not expect to be disbelieved?

Answer: No, I did not say so. I said last year that of course I did, and I exceed it every time.

Question 10954: *You are apparently not very ethical about motor-cars* [italics mine]. If you apply your principles as regards motoring to the physiologists, you have very little to say against them?

Answer: What I have to say is that they regard the Vivisection Act of 1876 with the same contempt that I regard the Motor-Car Act as regards the speed limit.

In quoting also a letter from the Home Office, Mr. Coleridge admits mutilating it, for in reply to Question 11015, he says, "I seem to have left out the important item of it." See also Questions 10301, 11011, 11024 and 19967 to 19973.

Comment on Mr. Coleridge's testimony is superfluous.

Again in the "Black Art of Vivisection," Mr. Coleridge

[1] In a letter referring to this address (Boston *Med. and Surg. Jour.*, July 11, 1912, p. 71), Mr. Coleridge says that I seem "quite shocked that he should admit that he constantly breaks the law and exceeds the speed limit of twenty miles an hour in his motor-car," and that "a quarter of a million motorists" do the same. If the reader will again peruse Mr. Coleridge's testimony, as quoted in the text, he will find that there are two admissions: (1) that he constantly breaks the law, i.e., the "statute law," of England as to the speed limit; and (2) that when he goes beyond the speed limit, and the policeman asks him, he says, "*No*, I am *not* going beyond the speed limit. The last statement is what gives special point to the quotation from his evidence, but in his letter he omits any reference to this more important admission of confessed falsehood.

states, "The Pasteur institutes in Paris and elsewhere have entirely failed to prevent people dying of hydrophobia." Yet the fact is that formerly from twelve to fourteen per cent of persons bitten developed the disease and every one of them died, whereas the result of the Pasteur treatment in 55,000 cases has diminished the mortality to 0.77 per cent of those bitten.

I cite another English instance. In "The Nine Circles" [1] is published a reply to a letter by Sir Victor (then Mr.) Horsley, published in the London "Times," October 25, 1892, a copy of which I have before me. A copy of the now rare first edition and these quotations from the London "Times" are in the Library of the College of Physicians of Philadelphia. The book, as the London "Times" points out in an editorial, was

> Compiled under his [Dr. Berdoe's] direction. He was entrusted with the task of reading the proofs and was supposed to safeguard the accuracy of "the compiler." He now admits that he overlooked in Miss Cobbe's preface a passage in which she "was careful to say, . . . so far as it has been possible, the use or absence of anesthetics has been noticed in regard to all the experiments cited in this book." Mr. Horsley, in the appendix to his letter, which we publish this morning, shows by reference to some twenty cases cited in "The Nine Circles" how entirely inconsistent with the truth this guarantee is, and Dr. Berdoe's reluctant acknowledgment completes the proof.

A still more remarkable letter appears in the same number of the "Times" from Professor C. S. Sherrington, of Liverpool. He says: —

> I find in the book, "The Nine Circles," three instances in which I am by name and deed held up to public abhorrence. From each of the three statements made about me the employment of anesthesia in my experiments is studiously omitted, although expressly mentioned in each of the published papers on which these statements are professed to rest. In two out of three statements I am accredited with inflicting on living ani-

[1] Second edition, pp. 23–28.

mals, and without the employment of anesthetics, a dissection and procedure that I *pursued only on animals which were dead.*

Accordingly, the society withdrew the book from the market, but later published a revised second edition.

In his reply to Professor Horsley's letter calling attention to the misstatements in the first edition, the excuses that Dr. Berdoe gives in this second edition are very extraordinary. Among them, for example, one is, "The sentence about testing the sight after recovery from the anesthetic was overlooked." Another excuse is, "This was taken at second hand from another report where the question of pain was not under discussion." In a third he says, "We have not always access to 'original papers' and can only rely on such reports and extracts as are given in the medical and other journals."

I ask whether it is fair, square dealing to base grave charges of cruelty on sentences "overlooked" and on "second-hand" misinformation?

But Miss Cobbe was by no means satisfied with misrepresenting English medical men. In the pamphlet "Vivisection in America," I find on page 9 a letter by a Boston lawyer in which he says of American experiments:—

> In other words, animals are dissected alive, *usually without the use of anesthetics*, for the supposed (but illusory) gain to science [italics mine].

I have already given a table showing that only twenty-six animals out of a thousand could by any possibility have suffered any pain, and that even these were anesthetized. Is it correct, then, to say that animals are "dissected alive usually without anesthetics"?

Near the top of page 45 Miss Cobbe's pamphlet reads as follows: —

> Dr. Ott, in the "Journal of Physiology," vol. II, p. 42, describes a number of experiments on a number of cats *not etherized* [italics my own], for the purpose of making observations on the physiology of the spinal cord.

I find that on reading the original paper there were four series of experiments:—

In the first series, there were twenty experiments. In the first experiment the animal was killed before the experiment began. In eleven other instances it is expressly stated in each experiment that the animals *were* etherized. Dr. Ott informs me that the other eight were so etherized and that he invariably etherizes the animals.

In the second series there were eight experiments. On page 52 of the "Journal of Physiology" it is stated that the animals *were* etherized.

The third series consisted of ten experiments, and on page 54 it is expressly stated that the animals *were* etherized.

The fourth series consisted of ten experiments and again on page 60 it is stated that the animals *were* etherized. We see, therefore, that Miss Cobbe's statement "not etherized" is untrue, for of forty-eight animals, one was killed before the experiment was begun; in thirty-nine it is expressly stated that they were etherized; leaving only eight out of forty as to the etherization of which nothing is said, though it was done.

On pages 45 to 48 I find a series of experiments on the surgery of the pancreas by the late Dr. Senn, of Chicago. This was in July, 1886, at a time when the surgery of the pancreas was just beginning. Two pages and a half of Miss Cobbe's pamphlet are devoted to describing in detail experiments which, as no mention is made in her pamphlet of ether, one would certainly suppose were done without ether and would surely be very painful. On looking at page 142 of the original paper I find that it is expressly stated that the animals *were* etherized.

In a series of experiments by Halsted, under experiment No. 6, p. 51, Miss Cobbe's pamphlet says, "Died under the operation, which was carried on for two hours on a young, small brindle dog," which would imply two hours

of "agony." The original expressly states the fact that this dog died *from the effects of the ether.*

So much for Miss Cobbe's idea of reproducing accurate accounts of the experiments to which she refers.

An amusing instance of misrepresentation is seen in an antivivisection comment made on one of Carrel's experiments on a cat. "How intense the suffering must have been to cause a cat (an animal usually so quiet and reposeful) to spend the day jumping on and off the furniture!" As a matter of fact, the kitten was only "playing with a ball of paper."

Another illustration of the way in which sentences are detached from their context and made to mean quite different things and repeatedly published years after the falsity of the statement has been demonstrated is shown by the constant inclusion of Sir Frederick Treves among the opponents of vivisection. He stated of one single investigation that operations on the intestines of dogs in his opinion — other surgeons do not hold the same opinion — were useless as a means of fitting the surgeon for operations on the human bowel. Ever since this utterance[1] Sir Frederick Treves has been constantly quoted in the manner mentioned, yet in a letter to the London "Times" of April 18, 1902, he says: —

> The fallacy of vivisection can hardly be said to be established by the failure of a series of operations dealing with one small branch of practical surgery. No one is more keenly aware than I am of the great benefits conferred on suffering humanity by certain researches carried out by means of vivisection.

This was noticed editorially in the "British Medical Journal" of April 26, 1902. So late as 1909, in the May number of the "Journal of Zoöphily," the editor-in-chief, Mrs. Caroline Earle White, reprints from the "North American" of April 12, 1909, her signed letter, and implies

[1] Sir Frederick Treves, *Lancet*, London, November 5, 1908.

that Sir Frederick Treves is an opponent of vivisection, seven years after this correction had appeared. In the number of the same journal for July, 1909, the associate editor of the journal prints a letter of denial from Sir Frederick Treves, and yet so late as the number for March, 1911, p. 177, the same old quotation from Sir Frederick Treves is published in the same journal which twenty-two months before had printed his own letter of denial.[1]

At the annual meeting of the Research Defense Society, Sir Frederick Treves, in referring to the great progress made in the science of medicine, said: "This progress has in the main been accomplished by experiments on animals." Ought not his name hereafter to be omitted from the list of the opponents of vivisection?

A postal card issued by the American Antivivisection Society in Philadelphia (there are several others of the same sort) presents a picture of a large dog with his mouth gagged wide open and his paws tied "without anesthetic." The object of the gag, of course, is to prevent the animal from biting before and while it is being etherized. It is absurd to state that this produces any pain, but a guide at the traveling antivivisection exhibition explained to two of my friends that it was used to *break the jaws of the dogs!* and that this was done "without anesthetics." But in nearly all our surgical operations within the mouth, on the tonsils, cleft palate, the tongue, etc., we employ gags of various kinds to keep the mouth wide open. To show how little annoyance this causes, here is a picture (Fig. 2) of a little girl, four years old, my own granddaughter, with a mouth-gag which I have used many times over with children and adults in operations about the mouth. This

[1] Just as I had corrected the proof of this paper, April 29, 1912, I received through the mail from Mrs. Caroline Earle White a reprint of her letter of April 12, 1909, with the same misleading quotation, thirty-three months after Sir Frederick Treves's letter of denial had been printed in her own journal.

Sir Frederick Treves, *Brit. Med. Jour.*, July 8, 1911, p. 82.

particular photograph, it will be observed, was taken also "without an anesthetic." It was not necessary to tie her

FIG. 2. Mouth-gag as used in operations about the mouth.

hands and feet as is done with dogs, for the child regarded the whole proceeding of photographing her with her mouth wide open as a "lark," and sat as still as a mouse. Is it necessary to add that her jaw was not broken?

Miss Britton, in her three-hundred-dollar antivivisection prize essay,[1] vividly describes an operation (removal

[1] *Our Dumb Animals*, January, 1910.

of the breasts of a nursing mother dog) which was *never done at all.* This fictitious operation is described in "The Nine Circles,"[1] again it appears in Dr. Albert Leffingwell's essay, "Is Science Advanced by Deceit," published in 1900. In 1901, Professor Bowditch called Dr. Leffingwell's attention to the fact that no such operation was ever done. In Dr. Leffingwell's collected essays entitled "The Vivisection Question," on page 169 of the second revised edition (1907), there is, in a footnote, a correction admitting that no such operation was ever done, but on page 67 of the same edition, a description of this same operation still appears uncorrected, six years after Bowditch's letter had been received and the misstatement acknowledged.

In the Antivivisection Exhibit which was shown in New York, in the winter of 1909–10, Professor Lee states that there was "an oven heated by gas-burners which contains the stuffed body of a rabbit and which the attendant tells you is used for the purpose of baking live animals to death, and this also is performed without anesthetics." Then to add still further pathos, the note at the end of the label on the oven said "gagging, muffling, or severing of vocal organs prevents tortured animals giving voice aloud piteously to such terrible suffering." As a matter of fact, "the oven is an apparatus intended for the *incineration of the . . . refuse of a laboratory!*" I might add that it is a constant practice in medicine and surgery now to use various forms of apparatus for the purpose of "baking" alive an arm, leg, or other part of the body, and lately a patient of mine has had her arm "baked" almost daily for weeks at a temperature up to 300° F. with great benefit.[2]

In the exhibit of the American Antivivisection Society in Philadelphia in November, 1911, a portrait of a dog was shown with a large placard stating correctly that the dog had been stolen from its owner and sold to the University of Pennsylvania for experiment. It omitted to state

[1] Second edition, p. 28.

[2] See *ante*, p. 8.

the further fact, which is perfectly well known, that the dog was kept for identification under Rule 1 (page 245), was claimed, identified, and turned over to its owner and *not used for experiment.* Such a placard, stating half the truth, but not the whole truth, inevitably leads the public to draw a false conclusion.

The bodies of three dogs were also exhibited, each labeled, "The Vivisected Product of a Philadelphia Laboratory." All show gaping wounds; one, in fact, has the entire abdomen and pelvis wide open. Such a condition is utterly incompatible with any research. Surgeons and physiologists, when experimenting on animals, are necessarily as scrupulously careful in their antiseptic technic as in operations on human beings. Wounds are accurately closed and carefully dressed. Any experimenter leaving wounds wide open and undressed as are those in these dogs would invite failure in every case, and when he published his results and had to confess to a high and needless mortality, he would discredit himself.

One of these dogs shows an absurd operation in the neck. The great blood-vessels from the right and left sides of the neck have been drawn together in front of the windpipe and then tied — a procedure that is unimaginable to any surgeon. Moreover, from the wide-open abdomen and pelvis the following organs have been removed: the stomach, all the large and small intestines, except a portion a few inches long, the spleen, the pancreas, both the kidneys and the bladder. The liver, however, is left. Cannot even any non-medical person of ordinary intelligence see that if all these organs were really removed and, in addition, the great blood-vessels of the neck on both sides were really tied, thus cutting off almost all of the blood-supply to the brain, and then the neck and the abdomen were left wide open, the death of the animal on the table would be inevitable?

About a dozen medical men, all teachers in medical

schools, after careful inspection of these dogs, unite in believing that all or nearly all of these mutilations must have been done *post mortem* and not during life. Moreover, there is no *evidence* that these animals were really "vivisected," that is, operated on during life.

Still further, granting that all these operations were done for research and during life, if the animals *were etherized* no pain would have been felt and no cruelty perpetrated. The significant omission to say anything as to any anesthetic, like the omission as to the restoration to its owner of the stolen dog, entirely misleads the public.

Dr. Henry P. Bowditch[1] quotes an extraordinary statement of the late Henry Bergh, an ardent antivivisectionist. Mr. Bergh says: —

> Robert MacDonald, M.D., on being questioned, declared that he had opened the veins of a *dying person*, remember, and had injected the blood of an animal into them many times and had met with brilliant success. In other words, this potentate has discovered the means of thwarting the decree of Providence when a person was dying, and snatching away from its Maker a soul which He had called away from earth.

I have happily been able to rescue quite a number of dying persons who but for my timely aid would have been dead persons. Instead of supposing that I had "thwarted the decrees of Providence and snatched a soul from its Maker," I have always been under the impression: (1) that it was not in my feeble power to thwart the decrees of the Almighty, and (2) the very fact that I was able to save a dying person from death was the best evidence that the decree of Providence was that the patient at that time should live and *not* die.

But it seems that in the catechism of antivivisection it is an impious crime to save the life of a *dying* person, though I suppose it is proper to save the life of a patient who is only "sick."

[1] Henry P. Bowditch, *Animal Experimentation*, p. 72.

In the "Journal of Zoöphily" for April, 1910, p. 44, under the caption "Still More Barbarity," is an editorial signed "C. E. W.," the initials of the editor-in-chief. In this editorial it is stated as to certain experiments of Dr. Wentworth, of Boston, that they were "upon between forty and fifty little children in the Children's Hospital of that city, every one of whom died after the performance of his operation." The "casual reader" would certainly understand that every one of these forty to fifty children died as a *result* of the operation.

Let us see what the *real facts* are.[1] In 1895, in a case of possible tuberculous meningitis, Dr. Wentworth did lumbar puncture in order to make a positive diagnosis. Lumbar puncture consists in introducing a rather long hypodermic needle between the vertebræ in the small of the back (lumbar region) and withdrawing some of the fluid from around the spinal cord. This fluid circulates freely to and fro both within the brain and its membranes and within the membranes of the spinal cord. The needle is inserted below the end of the spinal cord, rarely with general anesthesia, sometimes with local anesthesia of the skin, but generally without even this, as the pain is slight and only momentary.

In 1895 this method of diagnosis was very new. Its value was uncertain, its dangers, if any, were not determined. The appearance of the fluid and the nature of its microscopic contents in human beings were imperfectly known. Dr. Wentworth in this case used the method for diagnosis. Alarming symptoms appeared, but passed away. The child was proved not to have meningitis and "left the hospital shortly afterward perfectly well."

In order to determine whether this case was exceptional, and the dangers only accidental, or always to be feared (which if true might compel the entire abandonment of lumbar puncture), he repeated the operation most cau-

[1] Boston *Med. and Surg. Jour.*, August 6 and 13, 1896.

tiously at first and finally with surer faith in its safety and value in twenty-nine other cases. In fifteen of the thirty cases the puncture was expressly done in order to make a diagnosis — meningitis or other diseases of the brain and spinal cord being suspected. In the other fifteen cases, while there probably was no cerebral or spinal disease, it was of great importance to know whether examination of the cerebro-spinal fluid might throw any unexpected side-light on these diseases, and if not, it would at least disclose what the normal condition, appearance and microscopic contents of the fluid were.

Forty-five punctures in all were made on the thirty children. In three cases the puncture was made after death. Of the twenty-seven living children, fourteen died. *Not one of the fourteen died from the operation*, but, as the *post mortems* showed, from meningitis, tuberculosis, pneumonia, water on the brain, convulsions, etc., as is expressly stated in each case in the paper.

But the editorial says "between forty and fifty little children . . . *every one of whom* died after the performance of the operation." I have before me several antivivisection pamphlets published in New York, Philadelphia and Washington in which Wentworth's cases are narrated as cases of "human vivisection," and it is usually stated that "many of them died," but the reader would still suppose that it was as a result of the operation. In two of these pamphlets, "brief abstracts" of five cases are given, usually only one to three lines long. The *post-mortem* reports published in Wentworth's paper showed that these five patients died from meningitis (two cases), infantile wasting, tuberculosis and defective development of the brain and convulsions. Yet the "casual reader" would inevitably suppose that they died from the lumbar puncture as no other cause of death is stated in these pamphlets.

When Dr. Cannon pointed out the inaccuracy of the editorial of April, 1910, in the "Journal of Zoöphily," that

same journal in the issue for July, 1911, p. 219, in a paper signed "M. F. L." (the initials of its associate editor) not only did not acknowledge the error, but practically repeated it by saying that Dr. Cannon is "severe on the 'Journal of Zoöphily' for having referred last year to Dr. Wentworth's forty-five experiments on children and for having mentioned the fact that *the children died after the operation*" [italics mine].

Is it fair dealing to give such very brief abstracts and omit the most important facts as is done here? In 1901 I pointed out[1] these misstatements and what the truth was, but the same pamphlets have been constantly distributed without any correction. In November, 1910, nearly ten years after I had exposed the matter, Dr. Cannon states that one of these pamphlets was sent to a friend of his with a letter from the president of the New York Antivivisection Society, saying, "You may rely on them as being absolutely accurate and authentic!" Still worse: In April, 1910, "C. E. W." enlarges the number from thirty to "between forty and fifty" and actually says that "every one" of them died, and "M. F. L." practically repeats the misstatement by saying that "the children died after the operation." [2]

Suppose thirty friends dined together at the Bellevue-Stratford, then took a train and as a result of a collision fourteen were killed; would a reporter, and still less an

[1] "Misstatements of Antivivisectionists," *Jour. Am. Med. Ass'n.*, February 23 and August 10, 1901. (See *ante*, pp. 110 and 135 of this volume.)

[2] In Mrs. White's reply to this address (p. 144), she "pleads guilty" to the charge of misstating, as to these children, "that they all died," and says she "unconsciously exaggerated." On page 143 she states that she is "most particular to avoid not only falsehood, but even exaggeration." It is hardly correct to say that the statement that there were "between forty and fifty children" and that "they all died" is an "exaggeration" of the real fact, namely, that there were only twenty-seven living children operated on, and of the fourteen who died, *not one* of them died from the operation, but from well-known causes revealed by the *post-mortem* examinations and fully stated, in each case, in Dr. Wentworth's paper.

editor, be justified in stating in print, "Between forty and fifty friends dined last night at the Bellevue-Stratford. Every one died shortly after partaking of the dinner," entirely omitting the collision as the real cause of death?

Now, after fifteen years, what has been the result of these investigations by Dr. Wentworth and others? Lumbar puncture is a thoroughly well-established means of diagnosis. That it is attended with practically no danger is shown by the fact that it is now a routine practice in certain diseases, even much more important than recording the pulse and the temperature. Holmes[1] states that he has done the operation "over four hundred times and has never met with an accident."

It is not only always done in some diseases, but is repeated two, three or more times in the same patient in cases of cerebro-spinal meningitis. As I showed in my paper in the "Ladies' Home Journal" (April, 1910),[2] the son of then Governor, now Mr. Justice Hughes, of the United States Supreme Court, a student at Brown University, stricken with a violent attack of the epidemic form of the disease, had lumbar puncture done three times; the first time in order to make a diagnosis and also for the injection of Flexner's serum, the second and third times for two other injections of the serum, which snatched him from otherwise practically certain death.

In this disease, Royer[3] says, "It is absolutely necessary to do a lumbar puncture" to make a diagnosis, and Dunn[4] says emphatically, "Without lumbar puncture a diagnosis of cerebro-spinal meningitis is absolutely without value for scientific, statistical or therapeutic purposes."

As there are half a dozen different forms of meningitis, and the remedy for the deadly epidemic form is of no use

[1] Holmes, *Arch. Pediat.*, October, 1908, p. 738.
[2] "What Vivisection has done for Humanity," *ante*, p. 220.
[3] Royer, *Arch. Pediat.*, October, 1908, p. 729.
[4] Charles Hunter Dunn, *Am. Jour. Dis. Children*, February, 1911, p. 95.

in the other forms, lumbar puncture, the only absolutely positive means of differentiating them, cannot be dispensed with.

Moreover, its use has been broadened, as shown in the case of young Mr. Hughes. No longer are we content to use it merely as a means of diagnosis, but it is the *only* means of successful treatment of that terribly fatal malady. It is also used for diagnosis in several surgical diseases and injuries. Moreover, the method of spinal anesthesia, which is most useful in cases in which other methods of anesthesia are too dangerous, is exclusively by means of lumbar puncture, the cocain or other local anesthetic being injected around the spinal cord by the hypodermic syringe.[1]

When a witness is called, it is not allowable for the party calling him to accept a part of his testimony and refuse to accept the rest, yet this is precisely what the opponents of research do. They always cite, for example, the late Professor Bigelow, printing his earlier utterances based on the suffering he saw at Alfort in the pre-anesthetic days, but they carefully omit the following later expression of opinion:[2] —

> The dissection of an animal in a state of insensibility is no more to be criticized than is the abrupt killing of it, to which no one objects. The confounding of a painful vivisection and an experiment which does not cause pain — either because the animal is under ether, or because the experiment itself is painless, like those pertaining to the action of most drugs, or because it is a trivial one and gives little suffering — has done great damage to the cause of humanity, and has placed the opponent of vivisection at a great disadvantage. . . . A painless experiment on an animal is unobjectionable.

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[1] Those who wish to consult by far the best statement for general use of the steps by which epidemic meningitis has been conquered, and the results of the new but now thoroughly well-established serum treatment by lumbar puncture, can obtain a copy of Dunn's paper on this subject. No. 21 of the series in Defense of Research. (See pp. xix, xx.)

[2] Henry J. Bigelow, *Anesthesia: Addresses and Other Papers*, Boston, 1900, p. 371.

So, too, when the statements of Horsley, Ott, Crile, and others that the animals were anesthetized and suffered no pain are shown to antivivisectionists, they reply, "We do not believe it, for the only testimony to this insensibility to pain is that of the vivisectors themselves." They greedily accept as true all their other statements as to the operations they did, etc., down to the minutest details, but they refuse to accept those as to anesthesia. No court of law would sanction such a course.

In reviewing the preceding misstatements and those quoted in my former papers,[1] I have been compelled to conclude that it is not safe to accept any statement which appears in antivivisection literature as true, or any quotation or translation as correct, until I have compared them with the originals and verified their accuracy for myself. Not seldom this is impossible, as no reference to the volume, month, day or sometimes even the year of publication is given.

Lest the reader think this too severe a statement I will refer to only one instance in the anonymous pamphlet, "Human Vivisection," in addition to others already shown to be grossly inaccurate.

On page 9 in the account of Sanarelli's five experiments in the endeavor to inoculate yellow fever, the phrase "the final collapse" appears as an alleged translation of the original Italian. The word "*final*" does not occur in the original. Moreover, the collapse was not "final," for every one of the five patients recovered, yet the pamphlet says that "some if not all of them died." The phrases "scientific murder" and "scientific assassination" are also freely used. Even the cover and the title-page of this pamphlet have as a motto, "Is scientific murder a pardonable crime?" As not a single patient died, were they really "murdered" or "assassinated"?

[1] "Misstatements of Antivivisectionists," *Jour. Am. Med. Assn.*, February 23 and August 10, 1901. (See *ante*, pp. 110 and 135 in this volume.)

Conclusions

In thirty years the sixteen British antivivisection societies have received more than £100,000 ($500,000) according to Mr. Stephen Coleridge's testimony before the Royal Commission on Vivisection (Questions 10256 to 10260). The American societies have had many bequests given to them, and in the aggregate must have also spent a large sum of money.

On the other side, the friends of research and progress have had little money, have had to stop research and waste a deal of precious time in defending their beneficent researches from the attacks of the antivivisectionists; the rest of the time they have quietly gone about their business, adding to the sum of our knowledge and forging new and more efficient weapons against disease and death.

What, then, is the net result? What have the friends of research accomplished, and what achievements can the foes of research show? Let me put it in a contrasted tabular form and confine it to what has occurred during my own professional life.

The Achievements of the Friends of Research

1. They have discovered and developed the antiseptic method and so have made possible all the wonderful results of modern surgery.

2. They have made possible practically all modern abdominal surgery, including operations on the stomach, intestines, appendix, liver, gall-stones, pancreas, spleen, kidneys, etc.

3. They have made possible all the modern surgery of the brain.

4. They have recently made possible a new surgery of the chest, including the surgery of the heart, lungs, aorta, esophagus, etc.

5. They have almost entirely abolished lockjaw after operations and even after accidents.

6. They have reduced the death-rate after compound fractures from two out of three, i.e., sixty-six in a hundred, to less than one in a hundred.

7. They have reduced the death-rate of ovariotomy from two out of three, or sixty-six in a hundred, to two or three out of a hundred.

8. They have made the death-rate after operations like hernia, amputation of the breast, and of most tumors a negligible factor.

9. They have abolished yellow fever — a wonderful triumph.[1]

10. They have enormously diminished the ravages of the deadly malaria, and its abolition is only a matter of time.

11. They have reduced the death-rate of hydrophobia from twelve or fourteen per cent of persons bitten to 0.77 per cent.

12. They have devised a method of direct transfusion of blood which has already saved very many lives.

13. They have cut down the death-rate in diphtheria all over the civilized world. In nineteen European and American cities it has fallen from 79.9 deaths per hundred thousand of population in 1894, when the antitoxin treatment was begun, to nineteen deaths per hundred thousand in 1905 — less than one quarter of its death-rate before the introduction of the antitoxin.

14. They have reduced the mortality of the epidemic form of cerebro-spinal meningitis from seventy-five or even ninety odd per cent to twenty per cent and less.

[1] Mrs. White, in her letter (p. 144), argues that this statement is incorrect because, forsooth, yellow fever "is still flourishing in a number of places in South America, Central America, and Mexico." Of course it is, but all the world knows that if they adopted the methods of Colonel Gorgas in the Canal Zone, yellow fever would soon be banished from these other places. Since May 17, 1906, — over eight years, — not a single case of yellow fever has originated on the Isthmus!

15. They have made operating for goiter almost perfectly safe.

16. They have assisted in cutting down the death-rate of tuberculosis by from thirty to fifty per cent, for Koch's discovery of the tubercle bacillus is the cornerstone of all our modern sanitary achievements.

17. In the British Army and Navy they have abolished Malta fever, which, in 1905, before their researches, attacked nearly thirteen hundred soldiers and sailors. In 1907 there were in the army only eleven cases; in 1908, five cases; in 1909, one case.

18. They have almost abolished childbed fever, the chief former peril of maternity, and have reduced its mortality from five or ten up even to fifty-seven in every hundred mothers to one in twelve hundred and fifty mothers.

19. They have very recently discovered a remedy which bids fair to protect innocent wives and unborn children, besides many others in the community at large, from the horrible curse of syphilis.

20. They have discovered a vaccine against typhoid fever, which among soldiers in camps has totally abolished typhoid fever, as President Taft has so recently and so convincingly stated. The improved sanitation which has helped to do this is itself largely the result of bacteriologic experimentation.

21. They are gradually nearing the discovery of the cause, and then we hope of the cure, of those dreadful scourges of humanity, cancer, infantile paralysis[1] and other children's diseases.

Who that loves his fellow creatures would dare to stay the hands of the men who may lift the curse of infantile paralysis, scarlet fever, and measles from our children

[1] Since this was written (1912), the germ of infantile puralysis *has* been discovered at the Rockefeller Institute — that Institute so hated of all Antivivisectionists.

and of cancer from the whole race? If there be such cruel creatures, enemies of our children and of humanity, let them stand up and be counted.

22. As Sir Frederick Treves has stated, it has been by experiments on animals that our knowledge of the pathology, methods of transmission, and the means of treatment of the fatal "sleeping sickness" of Africa has been obtained and is being increased.

23. They have enormously benefited animals by discovering the causes and, in many cases, the means of preventing tuberculosis, rinderpest, anthrax, glanders, hog cholera, chicken cholera, lumpy jaw, and other diseases of animals, some of which also attack man. If the suffering dumb creatures could but speak, they, too, would pray that this good work should still continue unhindered.

In April, 1914, when Mr. Rockefeller gave $1,000,000 to extend the work of the Rockefeller Institute, to the study of animal diseases in a laboratory to be established in New Jersey, the antivivisectionists persuaded the Governor to veto the bill authorizing this eminently humane work!

The Achievements of the Foes of Research

1. Not a single human life has been saved by their efforts.

2. Not a single beneficent discovery has been made by them.

3. Not a single disease has been abated or abolished by them either in animals or man.

4. All that they have done is to resist progress — to spend $500,000 in thirty years in Great Britain alone, and very large amounts of money in the United States — and to conduct a campaign of abuse and gross misrepresentation.

5. They apparently care little or nothing for the continued suffering and death of human beings, the grief and not seldom the ensuing poverty of their families, provided

that twenty-six out of every thousand dogs and cats, monkeys and guinea-pigs, mice, and frogs experimented on shall escape some physical suffering.

6. They insist, therefore, that all experimental research on animals shall stop and — astounding cruelty — that thousands of human beings shall continue year after year to suffer and to die.

The Age of Experiment is the Age of Progress. This is true in mechanics, in engineering, in electricity, in every department of human knowledge in which experimental investigation is possible.

Medicine is no exception. Stop experiment and you stop progress. But while stopping progress in other departments only means that we shall have no further development in the external comforts and conveniences of life, the arrest of the experimental method in medicine means that progress in the knowledge of the cause and cure of disease shall stop and that our present sufferings and sorrowful bereavements from the onslaught of cancer, scarlet fever, measles, whooping-cough, and all the other foes of health and life — especially of our dear children — must continue.

In the last fifty years, by experimental methods, we have made more progress than in the preceding fifty centuries. I believe that if experimental research is continued and aided, the next fifty years will be still more prolific of benefit to mankind than even the past fifty.

I have absolute confidence in the humanity, the intelligence, and the common sense of this nation that they will see to it that this progress shall *not* be halted by the outcries and misstatements of the antivivisectionists.

Dr. S. Weir Mitchell, when visiting the Antivivisection Exhibition in Philadelphia, put the matter in a nutshell when he said to one of the guides, "Your exhibition is not

quite complete. You should place here a dead baby and there a dead guinea-pig with the motto, "Choose between them."[1]

[1] Of course, not all antivivisectionists are to be grouped with those who are responsible for the letters, the epithets, and the persistent misstatements mentioned in this paper. I have, for example, some most esteemed personal friends who are more or less opposed to research by means of experiments on animals. But I believe that most of the reasonable persons who take this stand are not well informed, either as to the character of such researches, to their profound importance to the human race and to animals, or to their wonderfully beneficent results. They are misled by the misstatements of the chief antivivisectionists, and their kindly hearts are so shocked by the asserted "torture" of dogs, cats, etc., that they lose sight of the real and horrible torture continuously inflicted on human beings by diseases which the advocates of research are endeavoring to banish. Had they ever stood as in the past I have stood, knife in hand, by the bedside of a gasping, livid child struggling for breath, ready to do a tracheotomy when the surely tightening grip of diphtheria made it necessary to interfere, they would hail with delight the blessed antitoxin which has abolished the knife and enormously diminished the mortality of that curse of childhood. They would surely bless God that such a discovery as this antitoxin could be made *solely by experiments on animals*. The sufferings of a few such animals are as nothing compared with the lessening of suffering and saving of life for multitudes of human beings (to say nothing of the saving of sorrow and suffering to their families and friends), not only now, but for all time to come.

THE ANTIVIVISECTION EXHIBITION IN PHILADELPHIA IN 1914[1]

It is difficult to write with calmness and moderation about the Antivivisection Exhibition, since it is such a mass of omissions and misrepresentations.

I protest against an exhibit which misleads the public into believing that operations on animals are generally done without anesthetics. This is untrue. Anesthetics are universally employed in painful operations with the exception of the extremely rare cases in which their use would vitiate the results. Moreover, they are so used as to produce total insensibility to pain. To animals under their influence no operation can cause any suffering. All persons who have had surgical operations know this. The omission of the etherizer, therefore, in pictures or descriptions of operations on animals is not a truthful representation. It wholly misleads the public.

. . . . . .

I protest against the impossible operations represented as the "vivisected products of Philadelphia laboratories." About a dozen teachers in medical schools, after inspecting the same or similar specimens in the exhibition a year ago, agreed with me that they had been probably done *post mortem* and not during life. There is not the slightest evidence that they were done during life. They are mutilations the like of which I have never seen in any laboratory. When wounds are made in animals by surgeons, physiologists or pathologists, they are closed with the most minute care. In this exhibit the wounds have been left wide open,

[1] Reprinted from the *Public Ledger* of December 9, 1913, by the kind permission of the editor.

and from the abdomen of one dog nearly all the internal organs had been removed — an absurdity in itself.

. . . . . .

I appeal to the knowledge and common sense of the vast majority of people who are not deluded by the gross misstatements of the antivivisectionists. If the latter had had their way for the last forty years, there would have been almost no progress in medicine and surgery and we should be practicing the old fatal surgery in vogue before Lister's day. Then two out of three compound fracture cases died. Now less than one in a hundred. Then ovarian tumor operations also had a mortality of two out of three. Now only one or two in a hundred. Then five to ten and sometimes as many as fifty-seven mothers out of every one hundred died in childbirth from childbed fever. Now only one in twelve hundred and fifty.

To-day, in spite of the overwhelming testimony of really competent medical men, the antivivisectionists actually declare that diseases are not caused by germs! Of course, therefore, they decry the use of the antitoxins in diphtheria, lockjaw, epidemic cerebro-spinal meningitis, and as a preventive of typhoid fever. Yet every well-informed physician and intelligent layman knows positively the enormous benefits of these remedies.

To show how serious a menace to progress, to life and health the antivivisectionists are, one of the leaflets in this exhibition attacks one of the most extraordinarily beneficent of recent researches, that upon the hypophysis or pituitary body. This little body, the size of a pea, lies at the base of the brain and is not rarely the seat of disease or of tumors. Up to only six to eight years ago its functions were not known. By experiments upon animals these functions are now known to some extent and found to be of vital importance. Blindness is a frequent symptom of such tumors and eventually life is destroyed unless an operation is done.

It is true that the dogs experimented upon suffered pain and doubtless felt wretched, for though the operations done upon them in order to ascertain the functions of this gland were done under an anesthetic, yet they could not be killed at once or the function of the gland would not be discovered. The only alternative is to watch the clumsy and confusing experiments of disease in human beings. This had been done for years without any definite results. The health and the lives of the former sufferers from disease of this gland had been sacrificed in vain. Many of them became cretins (idiots). Many overgrew and became loathsome in appearance and wretched in health. Many became blind, and many died.

Note now the benefits from the experiments upon animals. Already more than one hundred operations have been done, with a mortality of less than ten per cent. While writing this paper, Dr. Rodman E. Sheen, a most grateful young man of twenty-four, from Atlantic City, has called to see me to tell me of his remarkable case. In October, 1909, the sight of his left eye began to fail. By August, 1912, this eye was completely blind and the sight of the right eye was rapidly failing. Only by the kindness of his fellow medical students could he complete his medical course. On March 3, 1913, Dr. Harvey Cushing removed a tumor of this gland. Immediately his vision began to improve. He can now read large print and his sight is steadily growing still better. Without operation death would certainly have overtaken him. Ask him if he thinks that his life and usefulness were not worth more than the sufferings and the lives of the four dogs whose pictures are shown in the antivivisection leaflet attacking these researches, and of all the other dogs experimented upon. Do not forget also that in the future hundreds of other patients also will be saved.

Would it not be cruelty beyond belief if the search for the causes and means of cure of cancer, scarlet fever,

measles, mumps, etc., should be stopped? And yet this is exactly what the antivivisectionists are determined to do.

A card on the wall of the exhibition reads: —

> We indorse legitimate surgery but deny it has been advanced through vivisection.
> (Signed) The American Antivivisection Society.

Whose knowledge, opinions, and statements as to the value of vivisection will you trust? Shall it be those of Miss Lind-af-Hageby, Mrs. White, Mrs. Lovell, Mrs. Easby, and Miss Nicholson, the most active members of the American Antivivisection Society, women who have never studied medicine thoroughly if at all, or those of such life-long students and leaders in medicine as S. Weir Mitchell, Sir William Osler, William H. Welch, of Johns Hopkins; John B. Deaver, and men like them? The very question is an absurdity.

I have heard myself called a "hyena" before a legislative committee at Harrisburg. I have received letters addressing me as "you fiend" and even "arch-fiend" and cursing my sainted mother for ever giving me life. These are not pleasant incidents. I would far rather have the esteem than the hatred of these persons, but for one thing — a profound sense of the duty I owe to my profession, and above all to present and future generations of my fellow men.

For more than half a century I have spent my days and nights in the constant study of surgery. I have taught it to many thousands of students. I am nearing the end of a long and laborious life. I have had some small share in the wonderful progress of surgery during the last thirty years.

I appeal to my fellow citizens and fellow countrymen to believe me when I say that while clinical observation, sanitary engineering, etc., have done much to make this progress possible, the chief means by which medicine and

surgery have won their beneficent triumphs has been experimental research. To abolish all such research, as is the declared aim of the antivivisectionists, would be a disaster to animals themselves. Millions of animals have benefited by our knowledge derived from experiments on animals, by which hog cholera, chicken cholera, rinderpest, anthrax, lumpy jaw, and other diseases of animals have been checked, cured or abolished.

It would also be a disaster to the whole human race by preventing future researches which will equal if not surpass in value those of past years. Our descendants must not be abandoned to devastation and death from diseases, the cause, prevention, or cure of which are now unknown. The antivivisectionists in my opinion are enemies of animals and of the whole human race.

THE END

SELECTED QUOTATIONS

SELECTED QUOTATIONS

Lawson Tait: —

"Bacteriological experiments on animals have proved of great value." [1]

Professor Henry J. Bigelow: —

"The dissection of an animal in a state of insensibility is no more to be criticized than is the abrupt killing of it, to which no one objects. The confounding of a painful vivisection and an experiment which does not cause pain — either because the animal is under ether, or because the experiment itself is painless, like those pertaining to the action of most drugs, or because it is a trivial one and gives little suffering — has done great damage to the cause of humanity, and has placed the opponent of vivisection at a great disadvantage. . . . A painless experiment on an animal is unobjectionable." [2]

Sir Frederick Treves: —

"No one is more keenly aware than I am of the great benefits conferred on suffering humanity by certain researches carried out by means of vivisection." [3]

Sir Frederick Treves: —

"This progress [in the science of medicine] has, in the main, been accomplished by experiments on animals." [4]

Professor C. S. Sherrington, of Liverpool: —

"I find in the book, "The Nine Circles," three instances in which I am by name and deed held up to public abhorrence. From each of the three statements made about me the employ-

[1] *British Medical Journal*, February 11, 1893, p. 317. See *ante*, p. xiii of this volume.

[2] *Anesthesia: Addresses and Other Papers*, Boston, 1900, p. 371.

[3] *London Times*, April 18, 1902.

[4] *British Medical Journal*, July 8, 1911, p. 82.

ment of anesthesia in my experiments is studiously omitted, although expressly mentioned in each of the published papers on which these statements are professed to rest. In two out of three statements I am accredited with inflicting on living animals, and without the employment of anesthetics, a dissection and procedure that I *pursued only on animals which were dead.*" [1]

Mrs. Caroline Earle White: —

"The best plan would be for the experimenters to go to India where they could find as large a field for investigation as they require in the poor victims themselves. *Here is an opportunity such as is not often offered for experimenting upon human beings,* since, as they would invariably die from the snake-bites, *there can be no objection to trying upon them every variety of antidote that can be discovered.* Nothing seems to me less defensible than these experiments on the poison of snake-bites upon animals, since it is the one case in which they could be observed with so much *satisfaction and certainty upon man!*" (Italics my own.) [2]

Mrs. Caroline Earle White: —

"I take issue with Dr. Keen . . . where he says, 'These experiments cannot, nay, must not, be tested first upon man.' I assert, on the contrary, that in the majority of cases they must be tested first upon man or not tested at all." [3]

Unanimous report of the Royal Commission on Vivisection. On this commission the antivivisectionists were represented and joined in this unanimous report: —

"We desire to state that the harrowing descriptions and illustrations of operations inflicted on animals, which are freely circulated by post, advertisement, or otherwise, are in many cases calculated to mislead the public, so far as they suggest that the animals in question were not under an anesthetic. To represent that animals subjected to experiments in this country are wantonly tortured would, in our opinion, be absolutely false." [4]

[1] *London Times,* October 25, 1892.

[2] *An Answer to Dr. Keen's Address, entitled "Our Recent Debts to Vivisection,"* p. 10.

[3] *Ibid.,* p. 4.

[4] *Report,* 1912, p. 20.

Dr. Herbert Snow, of London, as quoted by Mrs. M. F. Lovell: —

"Research among the lower organisms is the main path to be followed in the ages yet to be." [1]

Dr. Herbert Snow, of London, in his evidence before the Royal Commission on Vivisection answered 326 questions in 1906. In 1911, he stated that he gave all this evidence "in utter ignorance of the vivisection question." [2]

The Honorable Stephen Coleridge, of London: —

"I drive a motor-car, and when I go beyond the speed limit, and the policeman asks me, I say, 'No, I am not going beyond the speed limit.'" [3]

W. W. Keen: —

"These resolutions — *i.e.*, in favor of Experimental Research (*vide* pp. xv-xviii) — represent the *collective opinion of the medical profession*, not only of Great Britain and America, but of the whole civilized world.

"*Per contra, there is not, so far as I know, a single resolution of any scientific body expressing the opposite opinion.*" [4]

[1] *Journal of Zoöphily*, July, 1914, p. 101.
[2] Dr. Snow's letter. *Public Ledger*, Philadelphia, March 6, 1911.
[3] *Report of Royal Commission on Vivisection*, Answer no. 10, 952.
[4] Preface, p. xviii.

A LETTER TO "LIFE"[1]

BY MR. CHARLES H. FAHS, MADISON, NEW JERSEY

(THIS letter [by a layman, be it observed] was sent to "Life" in criticism of the attitude of that paper toward the use of vaccines, sera, and vivisection. It was later returned to the writer as unavailable. . . . The document is so human, however, and is such a powerful appeal against the maudlin sentimentality of the antivivisectionist and antivaccinationist, that the "Journal" has asked Mr. Fahs's permission to publish it. The recent attacks of these propagandists against the use of tuberculin as "human vivisection" makes the publication of this letter the more timely. — THE EDITOR.)

DEAR "LIFE": —

You take your fling, and you must. That's your mission. But listen!

When Death first struck near me, I was but four years old, and it was my little sister that went — spinal meningitis. Serum therapy was yet to be. Last year my only boy lay in convulsions — spinal meningitis. A fast auto ride to a Brooklyn hospital. Antimeningitis serum used. Not another convulsion thereafter. I thanked God for Simon Flexner and his ilk and took courage. What would you have done? How would you have felt?

When Death struck near me the second time, it was a baby brother that went — diphtheritic sore throat. Antitoxins were unheard of as yet. When I took my family abroad for a winter three years ago, I felt easier when I discovered that the German town we had chosen for our stay had a high-grade laboratory where the diphtheria antitoxin had been developed. How would you have felt?

When Death struck near me the third time, again it was a younger brother who was claimed — infection following vaccina-

[1] Reprinted by the kind permission of the author and of the editor of the *Journal of the Outdoor Life* for September, 1914.

tion against smallpox which was active near by. We learned later that the alleged doctor who did the vaccinating had neither legal nor moral right to hang out a shingle, and bitterness was in my heart. Two years ago I was about to start for a long journey through Asia where smallpox was to be met with on every highway. In spite of sad memories, I had myself vaccinated before I sailed. What would you have done?

During the Spanish War I saw Death when its name was Legion. A score of times on a single afternoon I heard the muffled drums and saw the reversed arms as the melancholy processions left the fever hospitals. Inoculation for typhoid was unknown. On that Far Eastern trip of two years ago I was to face possible typhoid infection at almost every meal time. I was inoculated for typhoid before I started. What would you have done?

Seven years ago, physically undone, I lay in a hospital while capable and faithful physicians sought to ascertain the obscure cause of it all. Finally I was asked whether I was willing to undergo the tuberculin test (hypodermic) for diagnostic purposes. I consented. The reaction was severe, but it pointed the way, and the subsequent treatment for tuberculous peritonitis brought me back to health. Would you have consented?

As a lonesome boy on the farm I had a collie as a servant, companion, and pet. Because of disease he had to be shot, and my heart was broken. Never have I had a pet since. But I have children, and I am willing for all the dogs and cats and guinea-pigs to be sacrificed if these precious ones can be better protected against the hostile microbes of various kinds that have cost my home the life of one child and severe if not desperate illnesses for each of the other three within a single year.

The profession of medicine has not succeeded in isolating itself entirely from carelessness, inefficiency, selfishness, or even from hardness of heart with respect to suffering on the part of animals or folks, but I know too many physicians of a noble type, men of high worth in head and hand and heart, to subscribe to any broad indictment of the profession's personnel or processes.

In a word, "Life," I think you're honest, but I don't think you're fair.

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